on a continuous concrete retaining wall, the top of which is some 13 ft. above the elevation of the wagon floor. The north side of the building rests on steel columns 18 ft. c. to c. The columns are of H-beams on cast-iron bases which rest on concrete footings and capped piles.

The width of the wagon floor is 25 ft. at one end, running to 35 ft. at the other end. The width is spanned by built-up girders, which extend as cantilever arms 8 ft.

The wagon floor has a 12-in. base of granulated furnace slag, thoroughly wetted and tamped. Upon this are 1½ in. of concrete and a 1½-in. mastic top dressing hardened by a patent process that was used on all the concrete floors. The track floor has 6 in. of reinforced concrete. The roof consists of reinforced-concrete slabs on which a slag roofing was applied. The warehouse doors are of the steel rolling type. Both floors are divided by brick fire-walls.

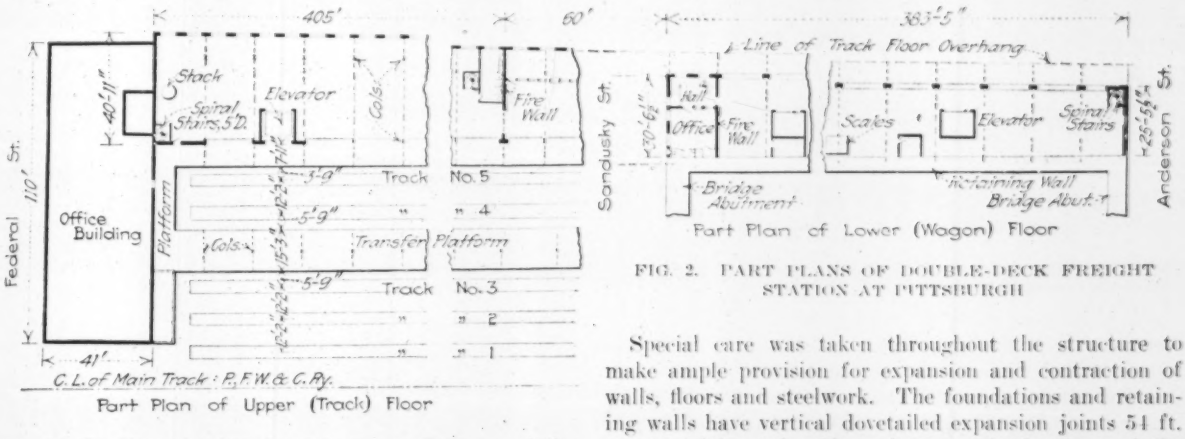

FIG. 2. PART PLANS OF DOUBLE-DECK FREIGHT STATION AT PITTSBURGH

beyond the line of columns, to increase the area of the upper floor and to form a shelter for teams and trucks along the wagon floor. Between the girders are 18-ft. I-beams, which support the reinforced-concrete floor.

The roof of the outbound warehouse is supported on steel trusses, and as there is a contemplated future development in the form of an additional floor in the inbound warehouse, the roof of that part is supported on girders

Special care was taken throughout the structure to make ample provision for expansion and contraction of walls, floors and steelwork. The foundations and retaining walls have vertical dovetailed expansion joints 54 ft. apart and located midway between the bearings of the girders. The joints were made by bulkheading the forms at every third bay (54 ft.), the amount poured each day. The groove of the joint was molded in each bulkhead, the cross-section dimensions of which equaled one-third of the top width of the wall. The molded groove was faced with tar paper before the next section was built, and in cold weather a greater amount of the paper was used to

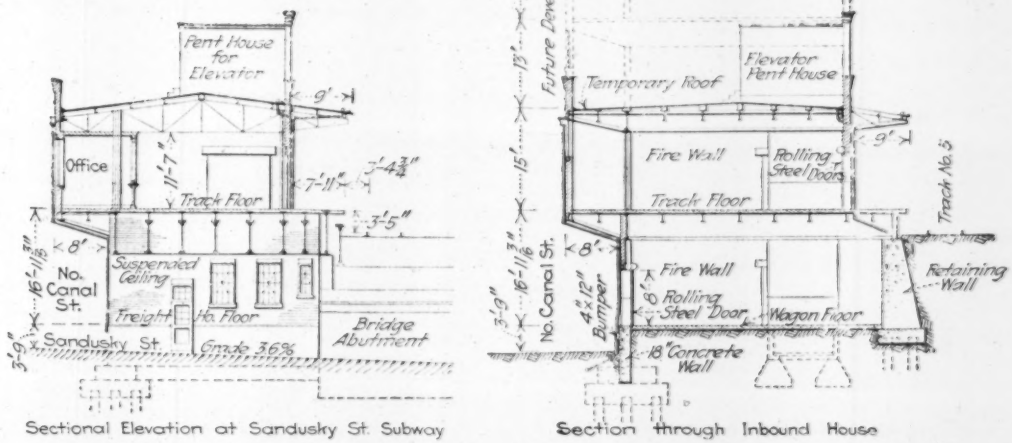

FIG. 3. CROSS-SECTIONS OF DOUBLE-DECK FREIGHT STATIONS; PENNSYLVANIA R.R.

that will later support the additional floor. This is shown in Fig. 3. The steelwork of the office building is similar to that of the freight station. The walls of the latter are of light brick laid in cement mortar, with concrete door sills, lintels and coping. The walls of the office building are of ornamental terra-cotta, and the windows and doors are finished with copper. A circular reinforced-concrete smoke-stack at the rear of the office building is 86 ft. high above the basement elevation.

increase the thickness of the joints. The bridge abutments were cared for in the same manner.

The concrete floors were all made with expansion joints 18 ft. apart. The joints of the reinforced-concrete track floor were made midway between girders, so as to overcome the tendency of cracks in the floor directly over each side of the girders, as the concrete was thinnest at these places owing to the cover plates and rivets of the girders. Special reinforcement was placed in the concrete over the

girders as a further prevention against cracking which would damage the floor. The steelwork was provided with expansion slots at each side of the Sandusky St. bridge. Expansion of brick walls and roof is provided for at the same places as the steel work.

Equipment and Miscellaneous

There are six electric freight elevators of 8500-lb. and two of 12,000-lb. capacity, all equipped with safety gates and having controllers on the cars. Automatic platform scales are provided in both warehouses. Spiral stairs are used, to economize space. Provision is made for electric lighting, steam heating and fire-prevention equipment.

To facilitate the handling of freight between wagons, trucks and platforms, North Canal St. has been regraded and paved with creosoted wood blocks laid on a sand cushion on a concrete base. Changes are made in the grades of Sandusky and Anderson St., to conform to the new grades of North Canal St.

For plans and information *Engineering News* is indebted to J. M. David, Engineer in Charge for the Pennsylvania R.R.

The Boulevard System of San Francisco

By James M. Owens*

Topographically the peninsula of San Francisco offers unequaled opportunities for the development of scenic boulevards—over rolling hilly country, through forests, along the bay shore, around the precipitous cliffs of its famous Golden Gate straits, or skirting the shores of the Pacific Ocean.

Recently a progressive municipal government has completed two of these boulevards; three are in course of construction, and plans have been adopted and funds set aside for others. These boulevards (see map) may be enumerated as follows: (1) Junipero Serra Boulevard (finished), (2) Sloat Boulevard (finished), (3) Portola Drive (75 per cent. finished), (4) Market St. Extension (Corbett Ave. Plan 1) (proposed), (5) Market St. Extension (Plan 2) (proposed), (6) 19th Ave. Boulevard (partly completed), (7) Ocean Boulevard (partly completed), (8) San Bruno Ave. Extension (partly completed), (9) the Great Highway and Esplanade (proposed improvement of).

The construction of the Junipero Serra Boulevard, the first of these scenic boulevards to be built, was briefly described in *Engineering News*, Feb. 18, 1915. Another important link—probably the most important if we consider its relative size and position—is the Sloat Boulevard, extending from Ocean Ave. to the waters of the Pacific, where it connects with the Great Highway.

Sloat Boulevard

The portion of Sloat Boulevard just completed is an asphalt pavement 30 ft. wide and 2.16 mi. long. This strip was designed as part of a proposed boulevard 135 ft. in width, with a double-track electric railroad in the center occupying a 35-ft. right-of-way, with 10-ft. walks on either side and 2-ft. concrete gutters.

Sloat Boulevard as originally constructed was 70 ft. wide, with a 35-ft. railroad right-of-way to the north, leaving a net available width of oiled-macadam roadway of 35 ft. In the design of the new 135-ft. boulevard, of which only a 30-ft. strip could be built at this time, it was thought advisable to use the grade of the old road as near as practicable, to save the old road base, which had become thoroughly compacted by years of travel, as a foundation for the new road. When the necessary property has been obtained on the northerly side of the boulevard the contemplated improvement can be made in its entirety, and will give to the city one of the finest automobile boulevards west of the Rockies.

Portola Drive

Portola Drive is the third link in the city's boulevard system. The construction of this boulevard is practically completed. It has a length of approximately 1.29 mi., a width of roadway of 40 ft., and a grade that does not exceed 5.92 per cent. for fully 90.5 per cent. of its length, and a maximum grade of 7.12 per cent. on the steepest portions of the remainder. Its lowest point is at an elevation of 260 ft. above city datum and its highest at an elevation of 586 ft.

The pavement has armored concrete curbs throughout and storm-water inlets at the various street intersections. The crown is 5 in., the base is of 6 in. of concrete, the asphaltic binder course is 1½ in. thick, and the asphaltic surface coat is 1 in. thick.

The road winds in and out through a forest of eucalypti and pines, with occasional vistas of the Pacific. It is almost devoid of tangents, and in general is made up of long and easy curves. It adjoins some of the finest residential tracts in the city. Along the line of this drive and its future easterly extension are two of the highest points in San Francisco, namely, Mt. Davidson and the Twin Peaks; while close to its westerly end lies the west portal of the Twin Peaks tunnel, just a little to the north.

Market Street Extension

Plan 1—Commencing at the present easterly termination of Portola Drive is a proposed extension which will be known as Corbett Ave. This is a part of the proposed extension under what is known as Plan 1 of Market St. to 24th St., where it will join with the remaining portion of the Market St. extension and continue on to Market St. at 17th St.

The section to be built under Plan 1 will consist of an asphaltic pavement 0.87+ mi. in length and 25 ft. in width. The base will be of concrete 6 in. thick, the asphaltic binder course 1½ in. thick, and the asphaltic surface coat 1 in. thick. A 5-ft. shoulder on the inner side, a 3-ft. concrete gutter, and an armored concrete curb complete the cross-section of the road as planned.

The average grade will be somewhat less than 6 per cent., and the maximum grade, which applies only for a short stretch, will not exceed 7.5 per cent. The highest point reached by this stretch of road will be at elevation 591, and the lowest, 511 ft. above city datum. This will be exceeded in height by only one other proposed boulevard, namely, the scenic drive that is planned to go around Twin Peaks mountain and reservoir. The estimated cost of this section of the Market St. extension, $40,000, is practically assured by the supervisors.

Plan 2—Beginning at 24th St. and joining with the section proposed under Plan 1, a second and final section of the Market St. extension is planned. This in its upper reaches will follow a winding course around the hills and connect with Market St. at 17th St., its extreme easterly

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end, close to the east portal of the Twin Peaks tunnel. It is expected that when this link is completed it will be one of the most popular of the scenic boulevards in the entire city, affording as it will from its upper reaches an unsurpassed view of the city, the bay, the bay cities and a portion of the Golden Gate straits. On the other side of the ridge are stretches of forest, occasional clearings and the Pacific Ocean to the west.

Nineteenth Ave. Boulevard

Nineteenth Ave. Boulevard, one of the oldest oiled-macadam boulevards in the city, is being reconstructed to form an asphalt pavement. One contract recently let has been completed, so that there is now a stretch of asphalt pavement 40 ft. wide and 4000 ft. long. There is also being paved a second stretch of 3320 ft., and proceedings are under way to finish the paving of the entire boulevard, which is a little over 2 mi. in length.

This boulevard runs almost due north and south and connects the Sloat Boulevard and Lincoln Way, passing through the Sunset district, one of the largest residential sections in the city. The specifications for paving this boulevard are similar to those of the other boulevards. The estimated cost of these two contracts is $71,940.65.

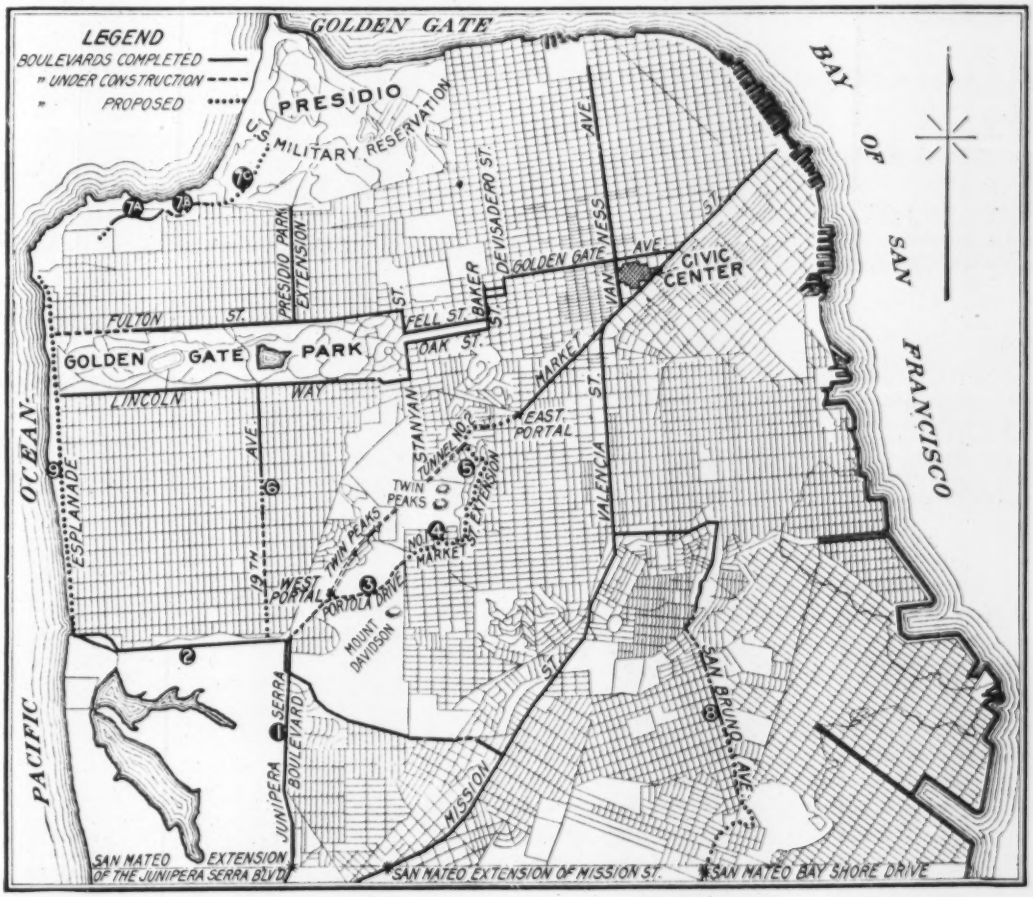
Ocean Boulevard

From the point of view of scenic beauty the boulevard planned for the north shore of the city, already partly constructed through the efforts of the city, the Panama-Pacific International Exposition Co. and the property owners, will probably surpass all the others. Although the alignment has been somewhat changed, the general plan proposed by the city engineer in 1913 very aptly describes the route as follows:

> A proposed Ocean Boulevard connecting the Exposition Grounds with the Cliff House and Ocean Boulevard, following the meanders of the bay shore, passing through the Presidio Reservation by way of Fort Winfield Scott, along Bakers Beach to Lincoln Park, and through Lincoln Park by way of Fort Miley Military Reservation to the Cliff House, thence to the Ocean Beach.

San Bruno Avenue Extension

Contracts have been let for paving and grading almost the entire unfinished portion of San Bruno Ave. so that when completed it will give a fine road to the county line, where it will join the recently completed Bay Shore Boulevard of San Mateo County. This will become a very popular drive, as it will afford egress from the eastern portion of the city, just as Mission St. affords a middle route and the Junipero Serra Boulevard a western exit down the Peninsula.



MAP OF SAN FRANCISCO SHOWING EXISTING AND PROPOSED SYSTEM OF BOULEVARDS

The Esplanade

With the assurance of an appropriation of $50,000 by the supervisors the initial work on the proposed Esplanade along the beach will no doubt soon be inaugurated, and in time the present antiquated and irregular, though scenically beautiful, Great Highway will give way to one of the most popular and elaborate boulevards in the system.

The entire work on this boulevard system is under the supervision of the City Engineer, M. M. O'Shaughnessy.

Building the Earth Embankment for Hill View Reservoir

By Arthur W. Tidd*

SYNOPSIS—Equalizing reservoir for Catskill water-supply system of New York City. Located just north of city line. Article details the method of stripping soil, laying 4-in. inner face, 2-ft. outer face, cleaning up slope and planting outside face.

Hill View reservoir, on the line of the aqueduct for the new Catskill water-supply for New York City, is located just north of the northern limit of the city of New York. It is an equalizing reservoir, the 900,000,000 gal. of water in the reservoir serving to modify the effect of the hourly fluctuation in the rate of draft in relation to the more uniform rate of inflow, and to maintain a nearly uniform head on the distribution system throughout the city. It also affords two or three days' supply in case of an accident to the aqueduct above the reservoir, and provides an ample supply for such an emergency as a large conflagration or a bad break in a street main in the city. The site is at the extreme southerly end of a comparatively narrow ridge, the highest site available for a reservoir in or near the city. By referring to the plan of the reservoir on page 501, noting the elevations of the adjoining property shown and knowing that the axis of the ridge runs from the position of El. 299 to that of El. 253, a very good mental picture of the site can be made.

Nature of Embankment

The reservoir is of the earth embankment type, an excavation having been made in the top of the ridge and the material so obtained placed around the edge of the site to form the reservoir embankment. About 3,000,000 cu.yd. of excavation were involved, the maximum cut being 44 ft. and the average cut 25 ft. The depth of water in the reservoir will be 36½ ft., the capacity about 900,000,000 gal. and the area of water surface about 90 acres. The elevation of the flow line is 295. The reservoir is uncovered and roughly rectangular, about 3000 ft. long and 1500 ft. wide. The formation is a very hard-packed, dense, glacial drift, containing many stones and boulders but no ledge rock. The material is well graded from a coarse sand down to a very fine rock flour, and is a most excellent one for a reservoir embankment. The sides of steam shovel cuts stood perpendicular for two years without change other than the scaling off caused by the action of frost.

The embankment may be described as an earthen dam constructed of carefully selected and thoroughly compacted material, and backed up by the remainder of the excavated material, which equals and in many places exceeds in volume that of the especially treated portion. The embankment on the water side was rolled in layer not thicker than 4 in. when compacted, while in the outer portion 2-ft. layers were allowed. It was on the outer portion that material unsuitable for the special impervious (4-in.) embankment was deposited together with the boulders or stones that the contractor did not elect to use for other purposes. The entire dependence for water-tightness was placed on the 4-in. or special impervious embankment (the former term was commonly used during construction, the latter one being the wording of the contract); the material in situ was impervious and no cutoff wall or core wall was provided. The bottom of the reservoir and the lower half of the inside slope were faced with concrete, but with no intention of providing additional water-tightness. No ledge rock and no springs were encountered in the excavation and no evidences of porous strata were ever observed; in fact, there was no stratification of any kind.

Preparation of Base of Embankment

The bonding of the base of the embankment with its foundation was done with extreme care. Portions of the site of the reservoir had been developed, roads laid out and several dwellings built, and there was one area of some 25 acres in use as a farm with house, barns, store houses and various outbuildings. The stripping of the top soil (which was done as a part of the contract) usually uncovered the original material; but around the dwellings a great amount of slow and painstaking work was required. Blind drains, pipe trenches, abandoned sewers, cesspools, and old cisterns were uncovered in the most unexpected places, and large fills of rubbish were found around the barns. Some fills were apparently made from cellar excavations and without careful scrutiny might have passed as material in its original position. All drains and pipes were followed to a terminus, the excavation being carried well below and on each side of the pipe. Over some areas a face cut was carried and the suspicions usually confirmed. As a final precaution before beginning the construction of the embankment, long test trenches were dug to intersect anything overlooked in the previous search.

From the finally stripped surface, small boulders and all stumps and large roots were removed. Large firmly embedded boulders were allowed to remain if there was room between them sufficient to operate the 10-ton steam rollers. Trenches were either filled by hand ramming or sloped enough to allow the roller to ride into and across them. Cisterns and the like were generally filled by hand ramming, as it was found that when filled by puddling it would be several weeks before the roller could cross them. Earth was placed around the boulders and rammed until sufficiently mounded to permit the roller to ride up onto them. Similar explorations were made over the base of the 2-ft. embankment.

Building the 4-In. Embankment

The stripped surface under the base of the 4-in. embankment was thoroughly scarified, usually with a road plow, to a depth of 3 or 4 in., and a thin layer of embankment material deposited and rolled. An excellent bond was thus effected between the original and the fresh material, and it may be stated here that this method was

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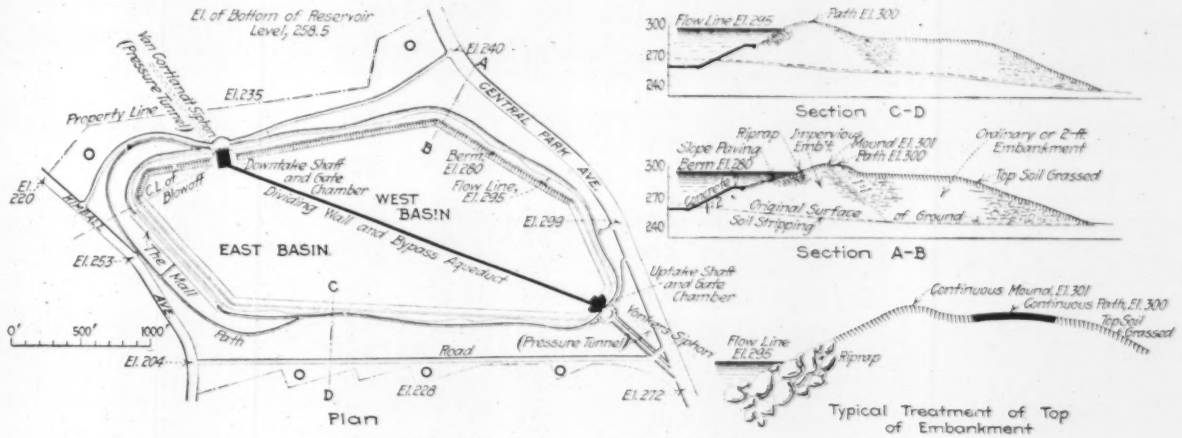
used throughout the entire construction of the embankment whenever work was started on an area that had lain untouched for a time. The 4-in. layers were then started, beginning in the lowest part, keeping the top of the embankment practically level both normal and parallel to the axis of the embankment.

No system could be introduced into the work until a considerable area had been leveled up; the dumping areas were restricted, irregular in shape, disconnected and often obstructed by boulders. As soon as possible, 3-ft. gage track with 65- to 70-lb. rails was laid on the embankment and the material brought on in cars—4-yd. side-dumping cars in 10-car trains hauled by 10- to 15-ton locomotives. The tracks were laid in straight stretches as long as possible; which was nearly 2000 ft. on the two long sides of the reservoir. Two parallel lines of track were used until the embankment became too narrow to accommodate them, that point not being reached, however, until near the top. The trains were dumped in succession along the full length of the track and the material spread and leveled with a spreader-car into a layer about 6 in. thick.

As soon as the spreader-car had finished, usually in about four trips, the track was pulled away a certain definite distance, lined up exactly parallel to the previous position and was ready for trains again (see view No. 9). The track was pulled approximately into position by three or four teams of horses and then lined up by a track gang, who adjusted the ties and did any necessary spiking and bolting. The amount of the track throw was determined from careful observations taken on the compacted layers, for each layer when spread must just connect with the edge of the previously spread layer and when rolled must be 4 in. thick. The steam-shovel runners became expert in loading the cars to the limit and at the same time with a very uniform volume, for it was on that uniformity of volume that the success of the whole method depended. The system worked admirably and was used for the bulk of the bank. The track throw was in general 14 ft. The spreader-car was not able to spread the full width even when counterweighted, 10 ft. being about its limit, so the remainder was spread with a 4-horse road scraper. A stone gang worked continuously picking out and removing the boulders and stones larger than 3 in., in order to allow the roller to get onto the layer at the earliest possible moment. Here again the steam shovel runners coöperated by avoiding the larger boulders when loading for the 4-in. embankment.

Ten-ton rollers with grooved front wheel and cleated side wheels were used. They were run back and forth parallel to the track, moving over the width of the side wheel (about 18 in.) on each trip, thus making four rollings on each layer. During hot weather, the material required sprinkling to insure proper bonding with the preceding layer and thorough compacting. The watering was done by an ordinary street sprinkling cart drawn by horses, and the water was applied to the rolled layer before the new layer was dumped. A sprinkling car was tried, but given up, as it interfered too much with the regularity of the train movements. Shallow test pits were dug from time to time in the 4-in. embankment to prove the thoroughness of the compacting. The results were entirely satisfactory; the line of demarcation between successive layers could not be detected except where different colored material had been used; the degree of compactness was very uniform. That the bank was practically impervious was evidenced by the behavior of the small ponds of rain water that collected from every storm.



DETAILS OF HILL VIEW RESERVOIR, CATSKILL AQUEDUCT

The run of the excavation was constantly watched, but very seldom was there found material unsuitable for use on the 4-in. embankment. Material once worked over, such as trimmings from slopes and temporary road or track embankments when removed, was sent to the 2-ft. embankment, as it was found to be unsuitable for 4-in. work, the physical characteristics having been quite changed by the second handling. Wherever ponds collected after rain, the water and mud were removed before fresh material was deposited. On portions of the bank where no work was being done, the ponds were allowed to evaporate; but all material washed or disturbed in any way was removed before preparing to resume work.

Some difficulty was experienced in securing thorough compacting wherever the direction of track shifting was reversed. This occurred at points where the work of one track connected with the portion of the same horizontal layer placed by the other track and also along the edges of the bank. In such cases it was necessary to place two layers one on top of the other before the track was shifted, and in the rush to take care of the material as fast as it was sent out from the steam shovels, great vigilance was required to insure that the proper amount

BUILDING the HILL VIEW RESERVOIR for CATSKILL AQUEDUCT NEW YORK CITY

① Typical cut for large steam shovels
② Excavation operations in progress
③ Building 4-in. embankment (on left) and 2-ft. embankment (on right)
④ Outside slope before smoothing up
⑤ Smoothing up and grading outside slope
⑥ Placing top soil by Koppel car method
⑦ Outside slope finally graded and top-soiled
⑧ Wheelbarrow seeding machine and roller
⑨ Pulling track on 4-in. embankment
⑩ Spreader car on 4-in. embankment
⑪ 4-in. embankment being built

of rolling was given the under layer. Modifications of the system were of course necessary at such places as temporary roadways, around structures and at the sharper changes of alignment in the embankment. Sometimes a big track shift would be made on a Sunday, leaving a portion of the bank unfinished. Here, the trains were usually supplemented by wagons (see view No. 3); but if of sufficient volume would be handled by a special single track where time could be taken to spot the cars and make the frequent necessary track changes. Altogether, only about 30 per cent. of the material was brought on in wagons. All spreading and leveling of the wagon dump was done with 4-horse road scrapers, after which it was rolled in the usual manner. In general, the bank was kept level as it was built up, but necessary depressions, as where the tracks came up out of the excavation, were left with a very flat slope in all directions. When the depression was filled and wherever the bank was brought up against a sloping surface, the layers were kept horizontal, each one being feathered out to a thin edge when it reached the sloping surface.

With the exception of a few very small local areas in the angles of the two gate chambers, the entire bank was consolidated with 10-ton steam rollers; hand ramming or puddling was done over those areas. No pipes or drains were allowed to be placed anywhere in the bank; all the water impounded in the excavation from storms was pumped out over the top of the embankment until the concrete conduit built for the purpose of draining the reservoir was completed. This conduit was located in the original material well below the base of the embankment, was thoroughly bonded with the sides of the trench excavated for it and provided with several concrete cutoff walls. It was absolutely the only opening through or beneath the embankment, the aqueduct entering and leaving by vertical shafts within the reservoir.

The delay on the 4-in. embankment caused by rain was slight where a systematic effort was made to keep the top on a light grade crosswise to insure a runoff. Where the top did not drain, the last layer would soften, ponds would collect and it might be several days before the bank would be properly dried out and ready to receive fresh material. If work was started before the bank was pretty thoroughly dried out, it soon became of a quaking, rubbery consistence, sinking under the roller and trains and coming to a smooth surface again after they had passed. Additional layers did not improve matters for they promptly developed the same characteristics. Such conditions of compacting were thought to be undesirable and were avoided. Work was continued into the fall as long as the fresh oncoming material would thaw out the frost in the preceding layer, that point being passed when the frost would have set in about an inch during the night. When the frost was entirely out in the spring, as determined by test pits, the bank was carefully scraped down to undisturbed material and work resumed. No especial treatment was given the bank during the winter.

Building the 2-Ft. Embankment

The outside or "2-ft." portion of the reservoir embankment, slightly more in volume than the inside or "4-in." portion and backing it up, so to speak, was built up practically in conjunction with it. When conditions of frost or rain prevented material being placed on the 4-in. bank, the output of the shovels would be sent to the 2-ft. bank with the result that it might be raised above the 4-in. Under favorable conditions, when all efforts were concentrated on the 4-in., that might get ahead of the 2-ft., but the two were never very far apart. The 2-ft. bank was brought up in layers about 2 ft. in thickness, the top being kept roughly horizontal. All material unsuitable for use in the 4-in. work, together with the boulders, was sent to the 2-ft. bank, perishable material of course being excluded. Boulders were not allowed to be nested, a minimum limit of 6 in. of earth in the clear between them being required. No especial consolidation of the layers was required. In general the material was delivered in trains. No such system was developed as on the 4-in. work, although a certain regularity was introduced by sending the entire output of some shovels to this bank. Wagons were used on this bank also, about 30 per cent. being placed by them.

It was somewhat difficult to keep the outer face of the bank to the proper lines. Contours of this face were given on the working drawings, showing a rolling, undulating surface and stakes were set on each 5-ft. contour to bring the bank up roughly in accordance with them. The fact that the contours were not straight lines often necessitated considerable track movement, which was not always properly timed. The inside face of this bank, that is, the junction between the 4-in. and the 2-ft., was a plane surface on a 1 on 1 slope and was readily carried up to line. Work was allowed to extend into the winter until settled freezing temperature obtained. It was not resumed in the spring until test pits showed that all frost was out of the ground.

Settlement of Embankment

No settlement of the 4-in. embankment was ever detected, and from the evidence deduced from concrete structures built upon it and grade stakes given, the settlement must have been extremely slight if any at all. In the 2-ft. embankment, the layers settled about as fast as placed, reaching a condition of equilibrium well within a year after placing, subsequent to which no further settlement was appreciable. The embankment was five years in building.

The relative volume of excavation and embankment could not be determined, as it was impossible to separate the material in excavation between 4-in. and 2-ft. embankment; furthermore no estimate could be made of the volume of the boulders.

Excavation Methods

All the material was excavated by steam shovels and about 70 per cent. sent out on trains (see views Nos. 1 and 2). As long as the complete steam shovel plant could be operated, that is until the bank became so narrow on top that the dumping area was restricted, the material was taken up out of the basin by two tracks, one at the north and one at the south end, using pushing engines when the grade required them. Both lines were relocated and regraded several times as the banks rose. The steam shovels used for the bulk of the excavation were four heavy ones (about 70 tons) and four light ones (about 30 tons). The large shovels worked in the heavy cuts, taking the full cut, 40 ft. at the deepest point, at one time. These cuts were, however, shot ahead of the shovel with black powder. The small shovels took the lighter cuts, and in a few cases ran through in two lifts. The material was handled in 4-yd. side-dumping cars in 10-car trains by 10- to 15-ton

locomotives running on 3-ft. gage track laid with 65- to 70-lb. rails.

A large number of boulders of all sizes up to 1 yd., and in some cases 2 or 3 yd. in volume, were encountered everywhere throughout the cuts and their handling became an important factor in the general excavation problem. The original policy adopted by the contractors was to save them in the basin for future use in paving, riprap or for crushed stone for concrete or road construction, but the accumulation interfered so much with succeeding excavation operations that the following seasons as many as possible were sent out onto the bank either to be buried in the 2-ft. embankment or rolled over the edge for disposal at a more convenient time. A large force using a portable gasoline air-compressor for drilling was employed continuously breaking up boulders. Winter work helped some, but the problem was an ever present and troublesome one. The embankment was designed to take care of the entire volume from the excavation and the work was so done. There was no surplus to be disposed of and no shortage to be made up from outside borrow pits.

The distribution of steam-shovel yardage over the five years' work from 1910 to 1914 inclusive is as follows:

Years of Service	Tons Rating	Total Excavation, Cu.Yd.
1	60	21,600
5	60	600,300
5	70	694,000
4	70	409,900
3	65	249,600
4 ½	30	277,500
4 ½	30	176,200
2	30	122,300
4 ½	30	289,400
		2,840,800

Although monthly outputs ranging from 20,000 to 24,000 cu.yd. per shovel were not uncommon from the large shovels in the early part of the work, the yearly figures shown are much more indicative of the rates that may be useful for future studies. The shovels were in use practically all the time.

Final Grading of Top and Outer Slope

Less than 15 per cent. of the area of the top and outside slope of the embankment was required to be finished to fixed lines and grades, those areas being the paths, the access roads to the gate chambers, the marginal path around the reservoir and the mall at the southerly end. The marginal path was on a level grade with a ridge or mound uniformly one foot higher on the water side to prevent surface water from the path entering the reservoir. No fixed or formal treatment was given the rest of the slopes, in fact every effort was made to avoid such an effect. The grading was done entirely by eye, the slope being treated in long stretches and on broad lines to secure, in so far as possible, the effect of natural hill slopes.

The roads and paths controlled the grading in their vicinity and therefore were graded first together with the laying of all drains for taking care of the surface water. A tentative location had been made and stakes set for them while the bank was being brought up, but the whole question was now studied afresh, using actual cross-sections of the bank. Both horizontal and vertical alignment were modified to minimize the amount of material to be moved and still carry out the proper effect from a landscape point of view. The curves were of long radius and the grades easy. Plows, slip scrapers and hand casting usually sufficed, but some wagon work was necessary at times. The marginal path and mound were brought up with a car dump, but the work was carefully done and was finished principally by hand with some scraper work (see views Nos. 4 and 5).

On the balance of the slope, plows and slip scrapers were used supplemented by a small force of men with hand tools. Very little movement of material longitudinally along the slope was required, the desired effect being obtained usually by rounding off the upper portions and slipping the material down the slope. In many places large gullies had been eroded by the elements during the several seasons that had elapsed while the bank was being built, but in most cases these were filled or leveled by local treatment without the necessity of bringing on additional material. Some of the boulders encountered in the "smoothing up" process were rolled down the slope and removed while many others were buried.

Placing Topsoil on Slope

The bank as finally graded was ready for the placing of topsoil without further treatment. The surface was loose as a result of working over it, and an excellent bond with the soil resulted. A small amount of soil was placed in the fall of 1914, and from the experience of that year, the two methods used for the rest of the work were evolved. The balance of the work was done in 1915. The soil had been stripped from the reservoir site in advance of all other work and deposited in five large piles around the edge of the taking and beyond the toe of the embankment slope, a total amount of about 100,000 cu.yd.

By one method the soil was loaded from the soil pile by hand into 1½-cu.yd. Koppel cars running on a 2-ft. gage industrial track, hauled up the slope with a cable by an electrically operated hoist located at the top of the slope, and dumped and spread by hand (see view No. 6). Two cars were handled at a time. They were hauled from the soil pile to the foot of the incline by a horse. The track was shifted after a section of soil had been deposited the full height of the slope. By running the hoisting rope around a sheave at the head of the incline, the sheave being anchored to a deadman by an adjustable line and moved whenever the track was shifted, the hoisting engine could handle a long stretch of slope from one position.

By the other method the soil was loaded from the soil pile by steam shovel into 4-yd. dump cars running on a 3-ft. gage track, hauled to the top of the slope in six-car trains by two 15-ton locomotives and dumped over the edge of the slope. Previously constructed permanent access roads and paths provided a convenient location for most of the track. From the track the soil was spread down the slope by one-horse slip scrapers. A modification of this method was used on some of the longest slopes whereby each car was dumped into a flat wooden box on runners holding a car-load. The box was hauled down the slope by a hoisting engine located at the foot of the slope, emptied by means of an additional rope from the hoist, and hauled back to the train again to receive the next carload. The soil was handled longitudinally along the slope from the windrow of loads by one-horse slip scrapers as before. By this modification the train was held longer than by the original method, but the scraper haul was much shortened. On all slip-scraper spreading, it was necessary to supplement the scrapers with a small force using hand tools to obtain a uniform depth of soil and a properly finished surface.

The Koppel-car method was economical where the haul was short, as on the east side, but the train method was better adapted to the long hauls.

The thickness of the layer of soil was generally 9 in. measured normal to the slope. The thickness was kept constant by means of short stakes or pegs driven at frequent intervals over the area being covered where soil was placed by the Koppel-car method, but where slip scrapers were used, it was necessary to test the thickness by small test holes.

Planting the Slope

The surface was prepared for seeding by a force with iron garden rakes. On the prepared surface, Bradley's seeding-down manure was spread to the amount of 600 lb. per acre, and the following mixture of grass seed sown:

	Lb.
Kentucky blue grass	10
Rhode Island bent	15
Red top	25
White clover	10
Timothy	5
Total per acre	65

In addition, rye to the amount of 15 lb. per acre was sown on the areas seeded in the fall, but in less amounts or omitted entirely on the spring work. The rye and fertilizer were sown by hand, but the rest was sown by a Thompson wheelbarrow seeder, sowing a swath 13 ft. wide (see view No. 8). After sowing, the soil was lightly raked and then rolled with a light wooden roller about 8 in. in diameter and 6 ft. long. On the slope, a small wheel was bolted to the handle and the roller lowered down and pulled back by a rope. One man could handle it on a short slope, but as most of the slope varied from 100 to 200 ft. in length, a light windlass mounted on a wooden frame was usually used. Two men were required on the windlass and one to guide the roller.

Sprinkling was necessary in the fall of 1914 to supplement the rains, a line of 2-in. pipe being laid with outlets for hose connections. Some revolving lawn sprinklers were used and on some areas a hose and nozzle. In general the grass came quickly and satisfactorily. Some annoyance was caused by weeds coming up from seed brought on from the soil piles.

The grass did not get a good start in places on the area sown in the fall of 1914, and some gullies were cut by the rains during the following winter and spring. There was no sloughing off or sliding of the soil down the slope. Repairs were made by driving down the slope with a wagon, dumping the soil where needed and spreading it with hand tools. The steepest slope was 1 on 2 and that obtained for only a few hundred feet near the downtake chamber, usually the steepest portion was nearer 1 on 3. No berms were built anywhere. The surface water intercepted by roads or paths was led by gutters to catch basins and taken into the drainage system built for the purpose. Gutters were usually paved but were grassed where the grade was light. At the time of writing the results obtained by the above described methods are entirely satisfactory. A small amount of erosion of the fresh top soil occurred during the heaviest storms on the slopes where the grass had not attained a good growth. Repairs were made by a small gang of men carrying sacks of soil, sprinkling it where needed and immediately scattering grass seed.

A previous article (*Engineering News* of Oct. 16, 1913) described the sanitary features of the Hill View reservoir work, quoting the sanitary provisions of the contract and giving in detail the way they were worked out. A large camp was built for the accommodation of the labor force, all wastes were disposed of by incineration or septic tank treatment and a constant supervision maintained over the health and living conditions of the employees. Portable pan closets were provided for the use of the men on the work. They were moved about as needed. One heavy galvanized iron pan, 15x18x8 in., was supplied to each closet. The pans were changed daily and the contents incinerated in a central incinerator.

J. Waldo Smith is Chief Engineer of the Board of Water Supply with Department Engineer Frank E. Winsor and Division Engineer Charles E. Wells in charge in the field. The contractor is the Keystone State Construction Co. of Philadelphia, Penn.

Statistics of the Earnings of Graduate Engineers

The dean of one of the state universities in the Middle West recently undertook an inquiry as to the incomes earned by graduates from the university's engineering school. Until 1905, the engineering instruction in the university was given by a department of civil engineering, but in the latter year a separate college of engineering was organized.

The graduates were asked to give their income derived directly or indirectly from their work as engineers or contractors for each year since graduation up to the present time, so far as they were able to report their income in earlier years from memory or records.

The blank sent to be filled out was inclosed in a blank envelope which was inclosed in an outer addressed envelope so that those compiling the records could not identify the person reporting or even his locality. It is noteworthy that only half a dozen of the graduates reporting were members of the American Society of Civil Engineers.

Replies were received from 46.5 per cent. of all the engineering graduates, and from these replies the statistics in the accompanying table were compiled.

INCOME STATISTICS OF GRADUATES IN ENGINEERING FROM A WESTERN STATE UNIVERSITY

Years Out of College	Number Reporting	Highest Income	Lowest Income	Average Income	Per Cent. Above Average	Per Cent. Below Average
1	166	$4,000	$150	$884	40	60
2	152	7,000	400	1,115	28	72
3	136	4,000	300	1,225	34	66
4	119	4,500	600	1,379	31	69
5	94	5,000	420	1,498	32	68
6	80	4,000	600	1,596	48	52
7	73	3,400	720	1,697	48	52
8	63	5,000	650	1,786	47	53
9	53	7,000	840	1,996	38	62
10	50	8,300	1,020	2,296	30	70
11	43	10,300	800	2,530	28	72
12	34	13,200	800	2,819	26	74
13	35	20,000	900	3,127	21	79
14	30	40,000	900	3,927	13	87
15	31	33,000	1,000	3,884	13	87
16	28	21,800	800	4,252	11	89
17	25	27,500	*	3,440	16	84
18	23	37,000	1,000	4,671	13	87
19	21	27,000	1,500	4,663	19	81
20	17	23,000	2,000	5,946	24	76
21	17	33,000	2,100	7,734	29	71
22	16	42,500	2,100	8,006	19	81
23	16	46,000	2,000	7,687	25	75
24	13	33,500	2,100	8,172	23	77
25	10	14,800	2,100	4,630	30	70
26	7	13,500	2,100	4,671	14	86
27	5	19,700	1,500	6,340	20	80
28	5	22,500	1,500	6,980	20	80
29	3	4,200	3,000	3,567	33	67
30	3	4,500	3,000	3,833	67	33
31	3	4,500	3,000	4,075	75	25
32	3	4,500	3,700	3,983	33	67
33	2	5,000	3,700	4,350	50	50
34	1	5,000	5,000	5,000	0	0
35	1	5,000	5,000	5,000	0	0

*Indefinite loss reported for this year.

Field and Office

Efficient Traveling Derrick

The Dravo Contracting Co., Pittsburgh, in its construction work on Ohio River dams and bridge piers, uses many self-contained rotating derricks of an original type. In the company's work these are called "whirler derricks." The drawing, Fig. 1, shows the standard 10-ton derrick as designed and built by the company. The structure is framed of timber and the power comprises a standard hoisting engine and a separate swinging engine. The hoisting engine also takes care of traveling, a line carried ahead and passed around a spool of the engine being used to move the derrick forward on its track.

The derrick comprises an underframe of 10x12 and 12x12, mounted on six small truck-wheels on 14-ft. gage. This underframe carries a circle rail about 16 ft. in diameter. The upper or derrick frame has a similar circle rail on its under side. Between the two rails is a roller or wheel ring held at proper spacing by a circular angle, which also serves as bullwheel for the swinging rope.

The mast (inclined) and the boom are both made of two timbers set in A-shape, which gives lateral stiffness in swinging. The boom is journaled on a shaft seated in the forward end of the main frame timbers, and thus transmits its thrust directly back to the tension guys at the rear of the frame.

These machines operate on a short section of track, which is shifted from the rear to the front of the machine as it moves forward. By this ready portability and their simplicity and ease of handling they prove convenient in a variety of locations, on cribs or coffer-dams as well as on land surface. They are easily dismantled for shipment.

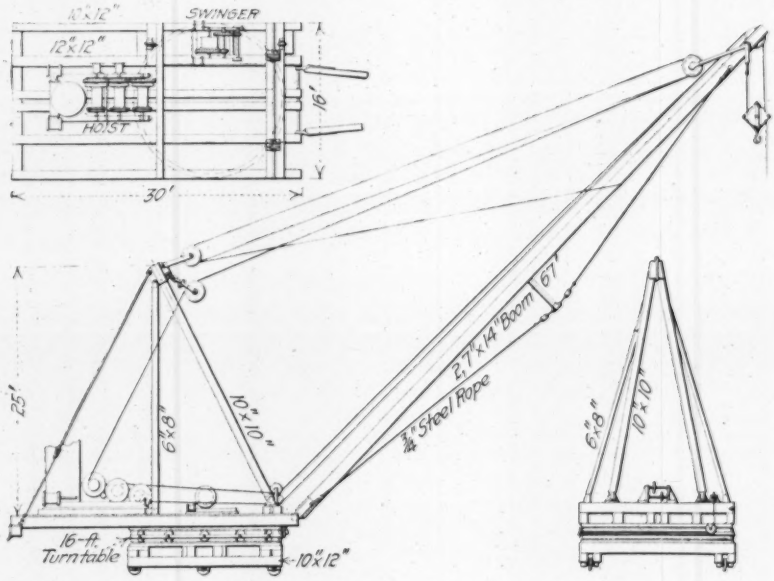


FIG. 1. STANDARD 10-TON WHIRLER DERRICK OF DRAVO CONTRACTING CO.

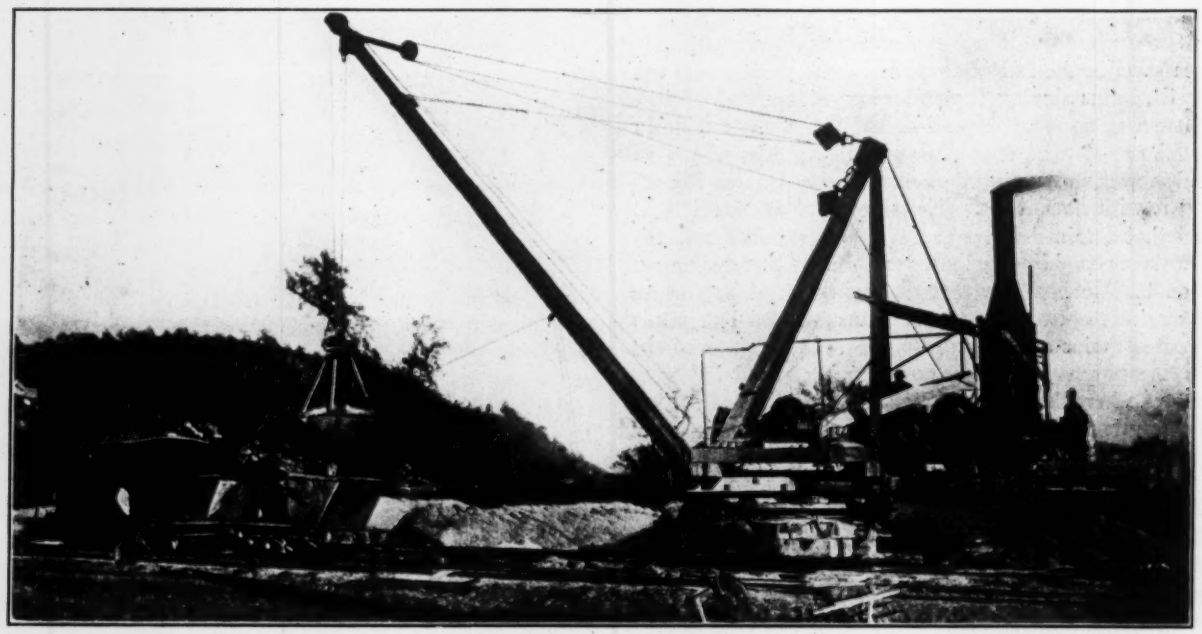


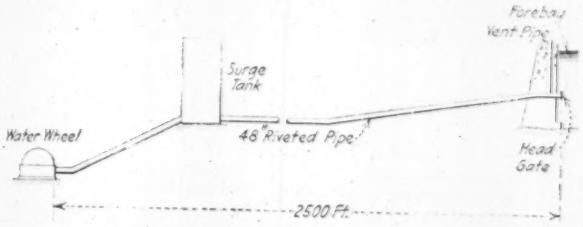
FIG. 2. DRAVO WHIRLER DERRICK ON PIER EXCAVATION FOR SCIOTOVILLE BRIDGE

Opening Headgate Causes Penstock Surges

By W. D. Spencler*

A most unusual and startling case of penstock surges has been dealt with by me, and as the trouble was so extraordinary the details are presented here for professional discussion.

There was a 48-in. penstock about 2500 ft. long laid nearly level for 90 per cent. of its length. There



PENSTOCK WHICH GAVE FILLING SURGES

was a drop of some 15 ft. in the first 100 ft. and a drop of 25 ft. in the last 50 ft. At the intake a 6-in. vent pipe was installed immediately back of the headgate for the specific purpose of furnishing air to the penstock when it was being drained. A head of about 12 ft. was imposed on this gate and the operation of opening was slow and somewhat more difficult than expected, for although 48 in. in diameter, it had no bypass or pilot valve.

In testing the penstock just after erection the foreman proceeded to open this gate and fill the penstock. The gate had been lifted a little, possibly an inch, when an explosion occurred and a spout of water shot out of the vent pipe and up into the air 60 to 80 ft. At the first explosion the foreman had jumped to a place of safety, but after a few seconds he returned and started to open the gate further. Then came a second explosion and water-spout. Without hesitating longer, he stepped to the bank of the ravine where he was safe and from here noted the recurrence of this phenomenon for several minutes. Each succeeding one was less violent, but all

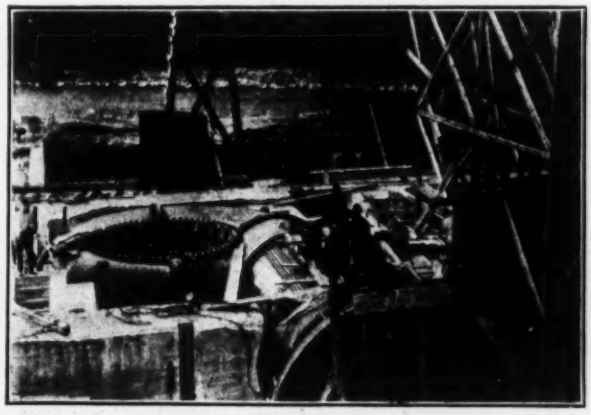


FIG. 1. TURBINE CASING AND STOP VALVE AT ONEIDA PLANT

occurred with regularity. After a time the pipe was filled and the action ceased. Upon examination no damage to the penstock or valve was found to have been done. Inquisitiveness led the foreman to empty the penstock and repeat the operation of filling it. As a rough means of judging of the force of water spouting from the vent pipe, he placed a barrel over the top of the opening. Under the first impulse this barrel was carried fully 50 ft. into the air and fell back over the concrete spillway into the ravine below. The regular series of explosions and spouts was repeated.

Although it may now be seen that the surges were caused by opening the headgate, this result could hardly have been predicted. The incident affords an excellent physical simile of the action of heavy surges in long electric transmission lines.

*606 Citizens Building, Cleveland, Ohio.

Two New Large Johnson Valves

Two 12-ft. Johnson cylindrical stop valves have been installed recently at the Oneida plant of the Utah Power & Light Co., near Phoenix, Utah, to control the admission of water to two 10,000-hp. turbines running under 140-ft. head. These are the largest valves of this type yet made.[1] The Oneida valves are set outside the foundations of the turbine casings to secure minimum size of building. Otherwise the valves would have been connected

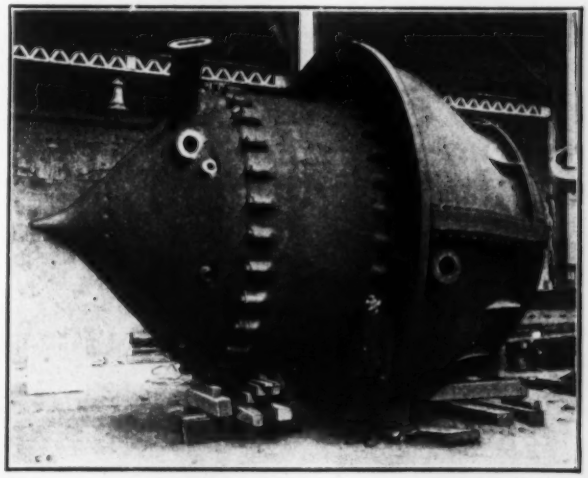


FIG. 2. CAST-STEEL CASINGS FOR 12-FT. JOHNSON VALVE

directly to the turbines. The rear part of the valve casing is of steel plate for economy; the rest is of cast steel, except for the bronze seat and ring.

When the valves are partly open the plungers may become unbalanced by débris and a transverse thrust be set up. Runways with monel-metal faces are provided to guide the plunger and prevent damage from this side thrust. A reach rod attached to the plunger works an outside indicator through a bell-crank shaft in a gland. Besides the indicator pointer, small incandescent lamps show ¼-, ½-, ¾-, and full-closed positions.

After the valve is calibrated it may be used as a venturi meter. The approach and throat ratio is 2 : 1 compared with 4 : 1 in the ordinary venturi tubes.

These valves were made by the Wellman-Seaver-Morgan Co., of Cleveland, Ohio.

[1]The design of this type was described in "Engineering News," Dec. 3, 1914. It consists essentially of a cylindrical body, forming an enlargement of the pipe line, with an internal cylindrical chamber containing a plunger of nearly the same diameter. The closed end of the inner chamber and the nose of the plunger are shaped to guide the water smoothly. The plunger seats against a ring in the outer casing.

Enlarging an Old Concrete Retaining-Wall

By George Paaswell*

In rebuilding an old embankment along the White Plains Road extension of the present Bronx subway, it became necessary to utilize the full width of the parcel for trackage on the road. This necessitated increasing the height of the original retaining-wall by about 11 ft. (see Fig. 1). For most of its length the present wall is on piles of which there are three rows, the spacing of the rows (longitudinally) being 3 ft. It was computed that the new wall with backfill would not overstress the piles, but that pending the placing of the earth backing the weight of the wall itself would seriously overload the inner rows of piles. Hence it was deemed advisable to drive another row (shown full in Fig. 1).

The derrick that was used for handling the spoil from the trench for the wall was also used for driving the piles, by a steam hammer working in leads suspended from the derrick boom.

The old wall consisted of 50-ft. sections, and the new wall of course merely extended these sections. The work was prepared for by excavating back of the wall, two sections or 100 ft. at a time. As the embankment was new it required heavy sheeting and timbering. Then the piles were driven.

There was one expansion lock in the old wall, and this lock was carried up through the new wall. The old lock stopped 2 ft. below the top of the old wall and it was necessary to cut out the concrete to reach it and make the pitch filler continuous at the joint. The old coping was removed to about 6 in. from the face of the wall, for architectural reasons and also to insure a better bond. Stonemasons trimmed off the broken part of the coping to obtain a straight line at the junction of the old and new wall.

The footing concrete was poured up to the batter point of the wall and large bond stones were inserted as keys. The forms were then built (see Fig. 2). A platform was built over the middle of the section and a mixer placed at each side. Closed chutes hung from the mouths of the mixers, and sections were added as required in the pouring.

The mixers were of the one-bag-batch type run by gasoline. This wall above the footing contained about 230 cu.yd. per 50-ft. section, and when light permitted we always attempted to pour it in one pour, running from 4 a.m. to 8 p.m. in two shifts. Only in one instance, however, were we successful in doing this. Usually the weather interfered or the mixers broke down. When there was doubt of completing the pour the lift was stopped 1 ft. below the top of the old wall (Fig. 1), a longitudinal timber form being inserted to constitute a key for the upper lift.

*Section Engineer, Public Service Commission for the First District, New York City.

The disadvantage of using small-unit mixers lay in the fact that the consistency of the batches varied considerably and the mixer required constant watching to prevent too wet a mix.

The face forms were stripped in 48 hr. and rubbed down. The back forms were left on longer as the sun shone directly on the back of the wall for a large part of the day and the concrete would have dried out too quickly. Although the original part of the wall is over five years old and a different brand of cement was used the wall appears monolithic at a comparatively short distance away.

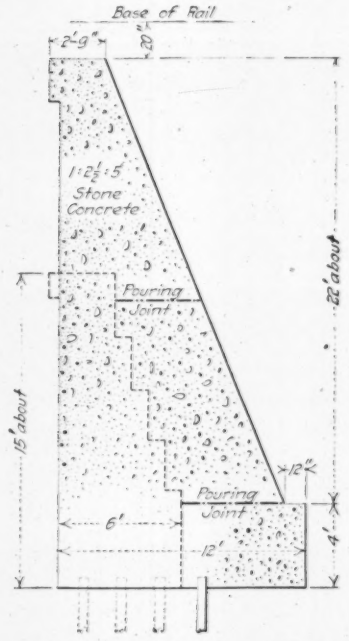


FIG. 1. OLD AND ENLARGED RETAINING-WALL

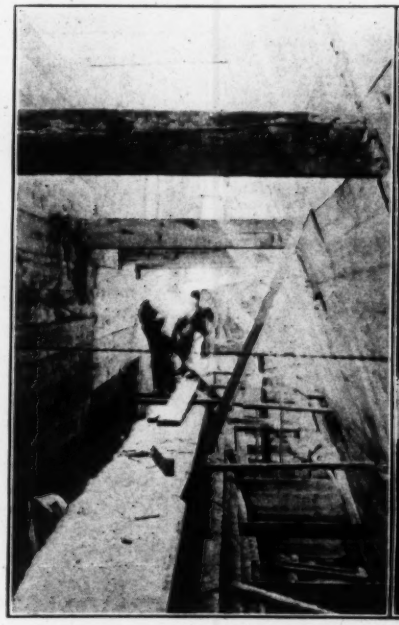


FIG. 2. INSIDE OF WALL FORMS

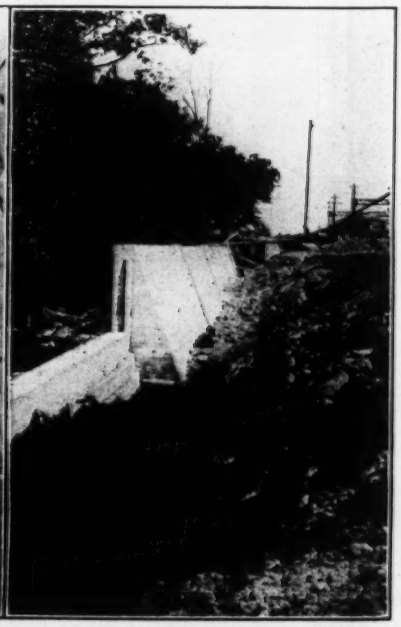


FIG. 3. COMPLETED SECTION OF WALL

The entire section of the wall that required enlargement was about 400 ft. long and contained a little over 1100 cu.yd.

The wall was built by the J. B. Malatesta Co., subcontractors for the Oscar Daniels Co., under the supervision of the Public Service Commission of the First District. C. V. V. Powers is Division Engineer, A. E. Clark Assistant Division Engineer in charge of all Bronx work, and the writer is section engineer.

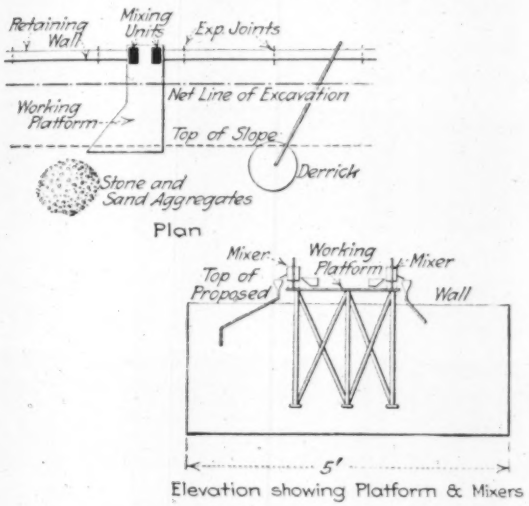


FIG. 4. LOCATION OF TWO-MIXER PLATFORM

Measuring Cement and Water in a Mixing Plant

The troubles that may arise from putting the wrong quantity of cement or water in a concrete batch are avoided by a pair of ingenious devices arranged by Harold E. Ketchum, contractor's superintendent, in the concrete-mixing plant used by the Hunkin-Conkey Construction Co. in building the east half of the Detroit-Superior viaduct, Cleveland.

Tipping Pan for Cement

The concrete is mixed in six-bag batches. Bags of cement are brought by a cable-hauled self-dumping car from the storehouse to the charging platform of the mixer house. The operation of emptying six bags into each charge involves delay, which is important whenever the concrete is being called for at maximum rates—and there is always the chance of the workmen making a mistake in the count, putting too many or too few bags in.

The charging hopper is double, one hopper under the stone gate and one under the sand gate of the bins above. A tipping pan has been set just alongside the sand hopper. The pan holds exactly six bags of loose cement. The cement handlers, therefore, need not count the bags, but simply fill the pan level full, which eliminates the chance of mistake. The pan being filled while the hoppers are discharging into the mixer and being refilled from the bins, it is ready to tip the cement charge into the sand hopper without loss of time.

The arrangement works well. It largely eliminates the necessity of an engineer's inspector on the charging platform.

On the opposite side of the charging hopper is a water barrel with a capacity equal to the water required for a batch. The 2-in. water pipe over the top of this barrel fills it up to a gage mark which defines the quantity needed for a batch. The barrel is tipped into the charging hopper while the stone is going down through into the mixer below.

As compared with the plan of running water by a pipe direct into the mixer, under control of the judgment of the mixerman, this arrangement is obviously superior. It goes a long way toward making successive batches of concrete uniform.

Diagram for Determining Pavement Crowns

By Charles W. Barber*

In determining the proper crown for asphalt- and concrete-paved streets of widths less than 50 ft., the formula, $C = \frac{W\ (100\ -\ 4\ P)}{6300\ +\ 50\ P^2}$ (T. J. Powell, *Trans.* Am. Soc. C.E., Vol. LXXIII, 1911, p. 225) is used by the Engineering Department of the District of Columbia. By combining this formula and the one for rate of transverse grade, $d = \frac{8\ C}{3\ W}$, I obtained $d = \frac{8\ (100\ -\ 4\ P)}{3\ (6300\ +\ 50\ P^2)}$. For this last formula the accompanying diagram, Fig. 1, is plotted.

It will be noted that the formula shows that the transverse grade is dependent upon the longitudinal,

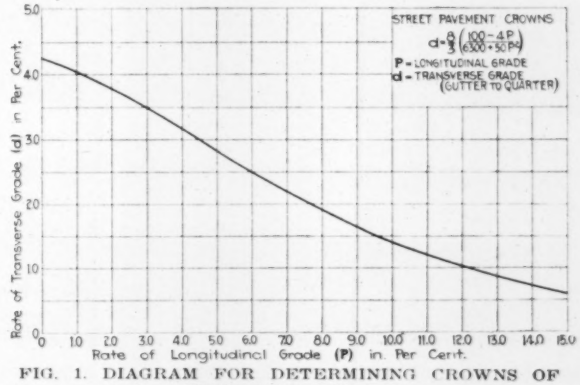


FIG. 1. DIAGRAM FOR DETERMINING CROWNS OF STREET PAVEMENTS

or curb, grade only, and does not include the width of roadway as do other formulas for determining crowns. Consequently the formula is readily adapted to diagram form. The basis of the formula, as mentioned by Mr. Powell in the reference given, is that a vehicle traveling upgrade along a line making an angle of 45 deg. to the curb line, in reality is very nearly on a level plane during the interval between the "quarter"[1] and the curb.

The method by which the transverse grade and crown cross-section are determined will now be shown.

C = Crown, or elevation of center of roadway above gutters;
d = Rate of transeverse grade, gutter to "quarter";
h = Difference in elevation of gutters;
P = Rate of longtitudinal grade (curb grade);
W = Width of roadway;
X = Eccentricity of high point of crown.

*Transitman, Engineer Department, District of Columbia, Washington, D. C.

[1]"Quarter" signifies the points midway between the high point of the crown and the gutters.

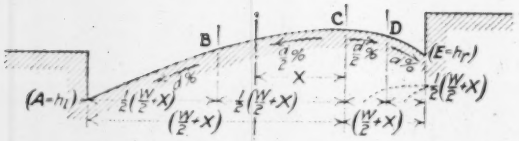


FIG. 2. METHOD OF DETERMINING PAVEMENT CROWNS

$X = \frac{h}{\frac{3}{2}d}$. Elevations are:

$A = h_l$	$E = h_r$
$B = \frac{1}{2}\left(\frac{W}{2} + X\right)d + h_l$	$D = h_r + \frac{1}{2}\left(\frac{W}{2} - X\right)d$
$C = B + \frac{1}{2}\left(\frac{W}{2} + X\right)\frac{d}{2}$	$C = D + \frac{1}{2}\left(\frac{W}{2} - X\right)\frac{d}{2}$

To Use the Diagram—We begin by knowing the rate of longitudinal grade and then trace this ordinate vertically to its intersection with the curve, which point we then trace horizontally to the left, where we read the rate of tranverse grade d.

Crown Cross-Section—The accompanying Fig. 2 and equations indicate the general method in which the crown cross-section is obtained. It should be noticed that when the curbs are level $X = 0$, and the high point of the crown is on the center line of the roadway.

Width of roadway (W)	=	30.00 ft.
Width of gutters	=	1.15 ft.
Elevation of left curb	=	86.67 ft.
Elevation of right curb	=	90.08 ft.
Rate of longtitudinal grade (P)	=	3.25 per cent.
Rise of gutter	=	0.10 ft.
Height of curb	=	0.52 ft.

Starting on the chart at $P = 3.25$, we find that this ordinate intersects the curve at $d = 3.40$ per cent. Our computations will be as follows (Fig. 3):

$$h = (90.08 - 89.67) = 0.41$$

$$X = \frac{0.41}{\frac{3}{2} \times 3.40} = 8.04$$

Subtracting the width of the gutter, W becomes (30.00 — 2x1.15) = 27.70

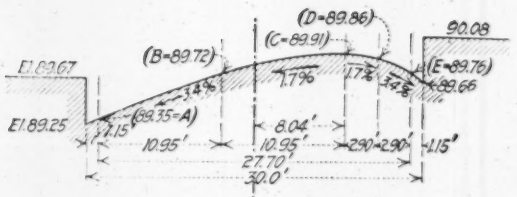


FIG. 3. ILLUSTRATING APPLICATION OF FORMULA AND DIAGRAM

Then

$$\frac{W}{2} = 13.85$$

$$X = 8.04$$

$$\frac{W}{2} - X = 5.81$$

$$\frac{W}{2} + X = 21.91$$

$\frac{1}{2}\left(\frac{W}{2} + X\right)$		$\frac{1}{2}\left(\frac{W}{2} - X\right)$	
10.95	10.95	2.90	2.90
0.0340	0.0170	0.034	0.017
0.3723	0.1862	0.0986	0.0493

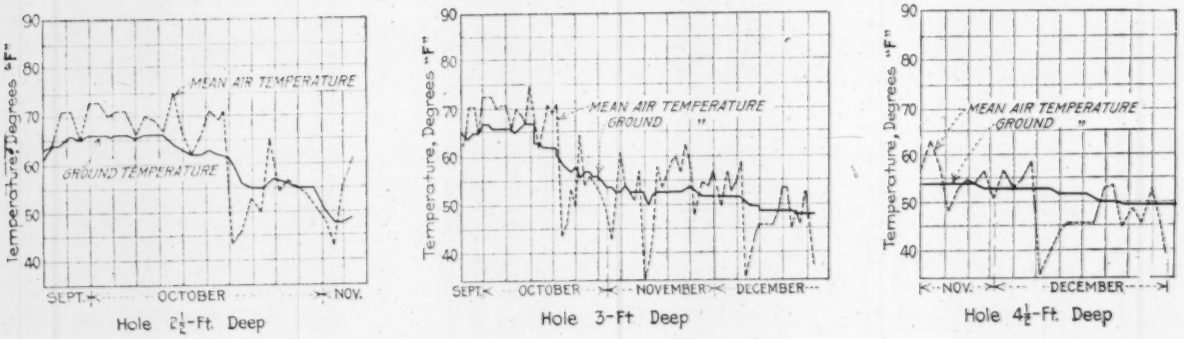
Elevations:

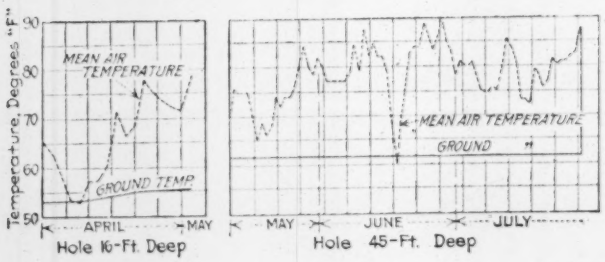
A = 89.35	E = 89.76
0.37	0.10
B = 89.72	D = 89.86
0.19	0.05
C = 89.91	C = 89.91

Ground Temperature Variations Decrease with Depth

By E. Lauchli*

In the notes on the design and construction of a reinforced-concrete dike dam at Mathis, Ga., in *Engineering News*, Sept. 2, 1915, was described the use of extra rein-





COMPARISON OF GROUND AND AIR TEMPERATURES IN BORE HOLES AT MATHIS, GA.

forcing steel in the cutoff wall made advisable to care for local stresses set up by the temperature changes at different depths.

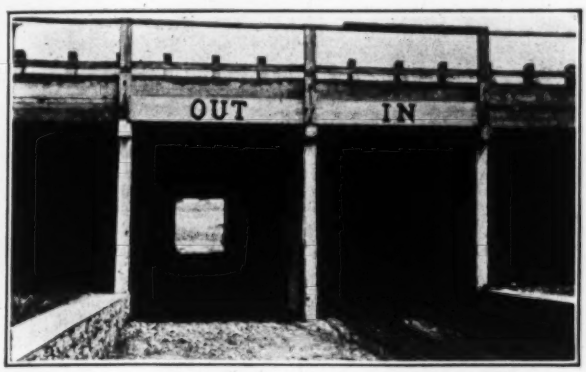
The accompanying curves show the result of the studies, undertaken in connection with this work, to

*2 Wall St., New York City.

ascertain the variation between ground and air temperature in various bore-holes of 2½ to 45 ft. depth. The curves require no explanation except perhaps to note that the ground temperature in the 45-ft. hole was the same throughout the year.

NOTES

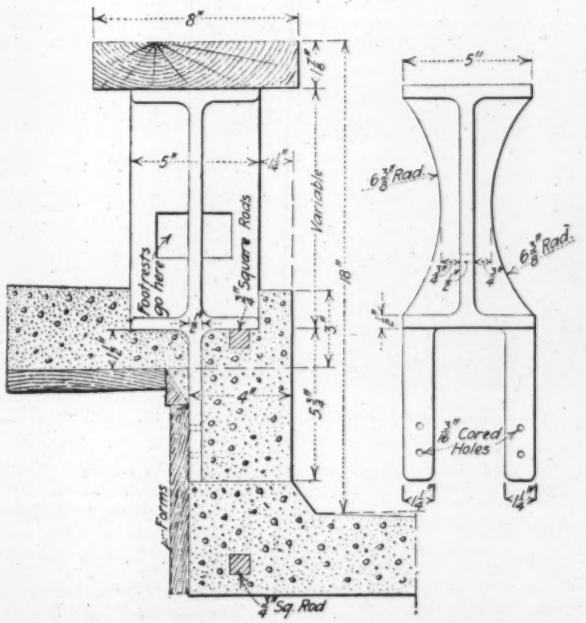
A Durable Timber Bridge is shown in the accompanying illustration. In spite of the fact that it carries an earth fill from 12 to 18 in. deep, it is sound and watertight. It was built in 1892 to form a subway under the Narragansett Park racetrack, near Providence, R. I. For many years this was a famous horse-racing track. It has been converted into an automobile speedway. The bridge is in 4 spans of about 8 ft. each.



A 23-YR.-OLD TIMBER BRIDGE WITH AN EARTH FILL AND A WATERTIGHT FLOOR

The 4x10-in. floor joists, spaced 2 ft. apart, are carried on 6x8-in. timber caps on rows of 6x8 in. posts. The floor is 3x10-in. planks, over which are four thicknesses of tar paper plastered on with hot tar. On top of this floor is the earth fill of the racetrack. The timbers are genuine long-leaf yellow pine and are as sound today as they were 23 yr. ago, and the floor is water-tight. Frederick E. Perkins in president of the Narragansett Park speedway.

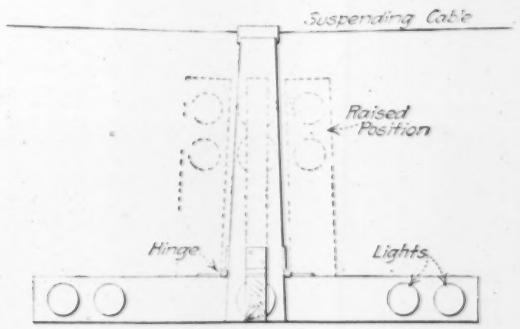
Cast-Iron Standards for Ball-Park Seats are being installed in the open stands and the bleachers of the new National League park on Commonwealth Ave. in Boston, Mass.



SEAT STANDARDS IN NEW BOSTON BALL PARK

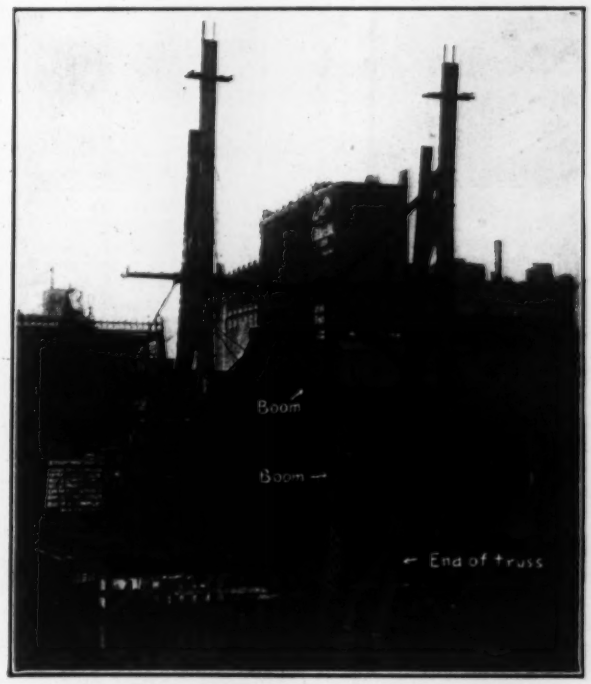
The stands in this park are of reinforced concrete, and in all of the open stands the seats are 2x8-in. plank screwed onto malleable cost-iron standards spaced every 3 ft. and embedded in the concrete of the steps during construction. About 12,000 of these standards are being used. The park structures were designed by the Osborn Engineering Co., of Cleveland, Ohio, and are being built by the James E. Gaffney Co., of Boston.

A Semaphore Type of Street Signal invented by a Cleveland policeman named Ketchum is being tried out in that city at the intersection of Euclid Ave. and East 9th St. Two cables are stretched from poles in diagonally opposite corners of the sidewalks. Hung from the wire cables at their intersections is a post about 3 ft. long, with arms



about 2 ft. long hinged near the bottom of the mast, as shown in the accompanying sketch. The signal is manually controlled by a policeman in a sidewalk booth. From levers here wires run to the signal, one for each blade or arm. The arms may be operated separately for left-hand turns, or in pairs for traffic moving along one street across the other and for right-hand turns. In addition to the position indication, in each arm is a red and a white light.

Failure of a Derrick on Bridge Erection—The fracture of a derrick iron caused the fall of a derrick, Aug. 25, while erecting the west leaf of the bascule bridge over the Chicago River at Jackson St., Chicago, Ill. The erection was illustrated



FALL OF A DERRICK WHILE ERECTING THE JACKSON ST. BRIDGE AT CHICAGO

in "Engineering News," July 22, 1915, but since that view was taken the leaf had been raised to a more nearly vertical position to keep its end clear of the channel. The derrick was placing a 22-ton section comprising the end panel of one truss

and a heavy transverse plate girder. The derrick iron holding the head of the mast to the stiff-legs broke, allowing the weight to pull the mast over. The steel boom fell across the completed work and doubled up, its main portion standing vertically with its head in the river. This is shown in the accompanying view, taken after the boom had been cut apart. The end of the truss panel is projecting above the water. The plate-girder was badly bent when recovered, being hauled up by means of tackle attached to the bridge.

Laying a Water Main Through a Storm Sewer—In the construction of an extension to the high-service fire-protection system of Boston, Mass., it was necessary to lay a 30-in. cast-iron pipe at right angles to a storm-water sewer having an internal diameter of 8 ft. As the top of this sewer was only 4 ft. from the surface of the street, which would allow insufficient cover for the water main, the sewer top was broken into and the main carried through the top of the sewer. To make a neat job and to create as little resistance as possible to the flow through the storm-water sewer, a

LAYING WATER MAIN THROUGH TOP OF SEWER

cast-iron cradle was designed to fit the diameter of the water main. This cradle rested upon the arch ring of the sewer where the latter was broken into. The accompanying view shows the main resting in the cradle. By the means described 28 in. of cover were secured over the water main. The bottom of the cast-iron saddle reached into the storm-water sewer a distance of 15 in. below the highest point of the crown of the arch.—F. I. Winslow, Engineer of Extension, Boston Water-Works.

The Great Northern Ry. Tunnel, 1733 ft. long, near Paola, Mont., with the exception of 500 ft. at the west end, was driven by the use of pneumatic-hammer drills of the "Jackhamer" type. The tunnel is 36 ft. wide and 32 ft. high, having a cross-section of 38 cu.yd. per lin.ft. The material is a sedimentary rock similar to soapstone in texture, but considerably harder. This rock is in strata inclined at 20 deg. to the horizontal and is very seamy and full of mud pockets. Water was frequently encountered. In the wall-plate drifts two 5-ft. rounds per 10-hr. shift could be driven, 14 holes 6 ft. deep to the round. This was possible because drilling could be resumed immediately after shooting, without loss of time in setting up bars and "mucking back." The rock remaining in the heading above the drifts was shot down upon traps erected in the drifts. A round here consisted of from 18 to 22 holes 10 ft. deep, which were drilled in from 3 to 4 hr. with two "Jackhamers." Ordinarily, drilling and mucking were completed in a half-shift. The most remarkable performance of the drills was shooting the bench ahead of the shovel. The "old timers" laughed at the idea and prophesied that tripod drills would have to be used. The bench contained 30 cu.yd. per lin.ft., and was excavated and timbered at an average rate of 20 lin.ft. per day. In order to break up this material, 60 to 70 holes 11 ft. deep were necessary. These were drilled with three or four "Jackhamers" regularly in 7 hr. An 11-ft. hole was frequently drilled in 10 min. The bench holes were drilled from the face because of insufficient overhead room to drill down holes. This prevented the drilling and the shovel excavation being carried on simultaneously.—H. King, of the Guthrie, McDougall Co., Paola, Mont.

Short Cuts in Surveying Computations—In examining the table on p. 363 of "Engineering News" of Aug. 19, 1915, I have been impressed with the conviction that a division by 43,560 can more easily be effected by the use of its reciprocal as a multiplier. If a given number of square feet is multiplied by 0.0000229568 the result will give acres and decimals. More conveniently this rule can be applied: Multiply square feet by 23 and point off 6 places, and multiply square feet by 43 and point off 9 places. Subtract the second product from the first and the result will give area in acres to a degree of precision within 0.001 acre in 100 acres. As an example:

4,356,000 sq. ft.		
× 23 and point off 6 places	=	100.188000
× 43 and point off 9 places	=	0.186908000
		100.001 acres

If greater precision is desired, instead of 43 use 432 as a multiplier for the subtractive quantity, pointing off in that case 10 places. Evidently, areas less than 10 acres may be obtained within a precision of 0.001 acre by using 4 as a multiplier instead of 43 and then pointing off only 8 places. Such a rule may be easily memorized or written in a notebook.—Horace Andrews, Albany, N. Y.

Conveying Automobile Parts by Wire-Rope Tramway between departments 780 ft. distant is now accomplished at Plant No. 3 of the Studebaker Corporation, Detroit, Mich. The carrier cable is 1¼ in. in diameter, the longest span being 178 ft. The traction cable is operated by a 10-hp. electric motor. The system is shown in operation in the accompanying view. By this means automobile bodies and wheels are sent to the

CABLE SYSTEM FOR TRANSPORTING AUTOMOBILE PARTS

assembling department. Formerly, these parts were taken down an elevator from the third floor of the finishing department, trucked through a tunnel to the assembling building, and there elevated to the fourth floor. By the old method 12 min. was required for delivery of a body, with four men to handle it en route. By the new method two men at each terminal tend the conveyor, and as many as 41 bodies have been delivered in 42 min. Steel trestles support the cables; at the buildings it was found necessary to erect steelwork from the ground to the proper height, to take the pull.

Editorials

Examinations for Commissions, Corps of Engineers

It was announced in *Engineering News* of Aug. 12 that a very, very narrow door had been again opened through which engineers who had graduated from other engineering schools than West Point might obtain positions in the Corps of Engineers, U. S. A. The official announcement of the examinations for such appointment, which will be held about Oct. 25, confirms the opinion then expressed that the door opened is so narrow that only an engineering graduate of very unusual ability will be at all likely to succeed in forcing his way through it.

In the first place, as already noted, candidates had first to take the examination for "Junior Engineer," in the engineer department at large. Those taking these examinations, which were held on Aug. 25 and 26, were required to have had "at least four years good civil, mechanical or electrical engineering experience," or to have graduated in engineering from an approved school. This examination for Junior Engineer occupied two days and it was announced that it would include nothing which was not covered by the courses in engineering given by reputable technical schools.

Those passing this examination who are graduates from an approved technical school, are between 21 and 29 years of age and are unmarried will be eligible to take the examination to be held by the War Department on Oct. 25 for a probational appointment as second lieutenant in the Corps of Engineers. The subjects covered in this examination are as follows: (1) English grammar and orthography; (2) elementary French, German or Spanish; (3) an optional subject to be selected by the candidate from a list submitted; (4) physics, including electricity and magnetism, sound and light; (5) chemistry, geology and mineralogy; (6) topographic, hydrographic and geodetic surveying, including the elements of practical astronomy; (7) descriptive geometry and drawing; (8) theoretical and applied mechanics; (9) theory and practice of engineering construction. It is noteworthy that subject 8 is given a relative rating of 18 and subject 9 of 30, while the first three points have relative ratings of only 4.

A candidate must pass a physical examination prior to the written examination, and also submit testimonials as to his moral character and fitness to hold a position as a commissioned officer.

According to the circular issued by the War Department prior to the examination a year ago, an average of at least 80% must be obtained by the candidate on the examination or he will be marked as failing. He will also fail if he does not receive a mark of 67% in any of the subjects listed. The probational appointment as second lieutenant is for one year only. At the end of the year a final examination is required on a dozen subjects of military engineering, including the candidate's military record and aptitude as certified to by the company, post and battalion commanders under which he has been. Candidates are required to obtain a mark of at least 75% in each subject included in this last examination.

As some of the readers of *Engineering News* may be interested in seeing what sort of questions are asked in the examination for a probational appointment, the examination questions used a year ago in the subject of theoretical and applied mechanics are given here:

THEORETICAL AND APPLIED MECHANICS

Part 1 (time, 3 hours).

I. Value, 7. 3 (a) Define stress; elastic limit; modulus of elasticity.

4 (b) A steel wire whose cross-sectional area is 0.01 sq.in. is to support a weight of 200 lb. as a pendulum. It has upon it two marks which are 200 ft. apart. What is the distance between the marks after the weight is added, the modulus of elasticity of the wire material being 30,000,000?

II. Value, 8. A flywheel whose mean diameter is 24 ft. is built up of four equal segments which are bolted together with two bolts at each joint. The rim is 4 in. thick and 18 in. wide and the material weighs 490 lb. per cu.ft. The wheel is designed for a normal speed of 75 r.p.m., and as a factor of safety the influence of the spokes was disregarded in designing the bolts. The safe stress on the bolts was assumed as 14,000 lb. per sq.in. What is the diameter of the bolts?

III. Value, 11. 6 (a) The coefficient of expansion for steel is 0.0000030; that for brass is 0.0000065. A steel column whose cross-sectional area is 5 sq.in. is 50 ft. long and is surmounted by a rigid crosspiece from the bottom side of each end of which hangs a brass rod whose cross-sectional area is 2 sq.in. Compute the length of the rods so that, regardless of temperature changes, their lower ends shall remain at the same elevation.

5 (b) If the rods are assumed to be 35 ft. long and have their lower ends immovably fixed, what total stress will be induced in the anchorage by a fall in temperature of 150°? Modulus of elasticity of brass is 10,000,000.

IV. Value, 13. 7 (a) Given the following beam without weight: Starting from the left-hand side there is a cantilever 5 ft. long to the support A. This cantilever is loaded uniformly with 1 ton per foot of length. From the support A to the support B the distance is 20 ft. Beyond B there is another cantilever 9 ft. long loaded with a concentrated load of 2 tons at its outer end.

Determine the amount and position of a concentrated load such that the beam may be cut through beneath it without disturbing the equilibrium of the system.

6 (b) Construct the shear and moment diagrams of the above beam with the unknown load added. Shear scale, ¼ in. per ton; bending-moment scale, ⅛ in. per ton-foot.

V. Value 11. 6 (a) A bar of steel whose modulus of elasticity is 30,000,000 is placed in a testing machine and subjected to tension. The cross-sectional area of the bar is 4 sq.in., its length is 20 ft., and its elastic limit of 60,000 lb. per sq.in. is reached in 15 seconds. What horsepower must be supplied the driving motor, assuming its efficiency to be 85% and that there is 10% loss of power in the testing machine?

5 (b) If the machine is provided with suitable reducing gears and with an automatic clutch designed to slip when the pull on the motor pinion (2 in. in pitch diameter) exceeds 40 lb., what must be the least speed of the motor at its maximum delivery during the above test?

Part 2 (time, 3 hours).

VI. Value, 10. 3 (a) In making compression tests of cast-iron columns 15 ft. long and 48 sq.in. in cross-sectional area the elastic limit of the material was reached at a unit pressure of 15,000 lb. per sq.in., the material having a modulus of elasticity of 15,000,000. Determine the resilience of the columns.

3 (b) Determine the modulus of resilience of the material.

4 (c) What load falling from a height of 4 ft. above the column will also strain the column to its elastic limit?

VII. Value, 7. A shaft in two parts is coupled with a coupling having in it 8 bolts, the bolt circle diameter being 18 in. The shaft transmits 1000 hp. at 500 r.p.m. If the safe load on the bolt material is 6000 lb. per sq.in., what is the diameter of the bolts?

VIII. Value, 8. 4 (a) Find the thickness of a spherical shell 6 ft. in diameter which is used as a receiver for compressed air at a pressure of 240 lb. per sq.in. above the atmosphere, the allowable unit stress of the material being 8000 lb. per sq.in.

4 (b) How great may be the diameter of the copper delivery pipe whose walls are ½ in. thick and whose safe load is 3000 lb. per sq.in.?

IX. Value, 13. 5 (a) An open caisson 50 ft. long and 10 ft. wide (inside dimensions) has been sunk in still water which has risen to a height of 36 ft. above the bottom of the caisson. The sides and ends simply rest on the bottom and the sides are supported by the ends. The ends are protected against collapse by longitudinal braces. Two cross-members are placed across the ends with their centers at heights of 5 ft. and 24 ft., respectively, above the bottom. Against these butt the longitudinals, being centered vertically on the cross-members, but horizontally their centers are 1 ft. in from the sides; they are 8 in. by 8 in. in cross-section, and there are four of these longitudinals in all. Neglecting friction, what is the unit pressure on the ends of the longitudinals?

4 (b) The pier within the caisson weighs 165 lb. per cu.ft. and is 45 ft. long and 5 ft. wide, and at the present stage of water it just prevents movement of the caisson. The caisson itself is neutral as to buoyancy. How high is the pier?

4 (c) As a matter of safety the caisson is allowed to flood to a depth of 25 ft. At what stage of the water will the previous condition of instability obtain?

X. Value, 12. 6 (a) A dam having a vertical face on the reservoir side is 175 ft. high and the water behind it stands at 160 ft. At a depth of 150 ft. below the crest is the top of the rectangular opening delivering water to the penstock supplying a turbine. The opening is 4 ft. wide and 8 ft. high and is closed by a sliding valve, the valve being operated by a vertical rod from above. The penstock has a cross-sectional area equal to that of the opening, and the water flowing through it supplies a turbine which is direct-connected to an electric generator; the efficiency of the turbine is 75% and that of the generator is 92%. What must be the size of the valve rod when safely loaded to 16,000 lb. per sq.in., the coefficient of friction of the gate under pressure being 0.3?

6 (b) If the velocity of flow in the pipe is 47 ft. per second, what kilowatt energy is being delivered by the generator?

Breadth vs. Specialization in Engineering Study

The ruin of a vessel within three months of its launching described elsewhere in this issue, may serve a useful purpose in calling attention to the value to an engineer of information on a wide range of engineering work. Nothing is more common than to hear engineers and especially young engineers declare that they have no interest in engineering literature outside their own field of work. That contains, they say, all that they can possibly find time to read about. They propose to keep up to date in that and to let the rest go.

Such narrow specialization as this is responsible for many failures in engineering work. A man accustomed to civil-engineering work, for example, finds it necessary to design a special machine for use upon some work, and because of his limited knowledge of mechanical engineering he does not make sufficient provision for lubrication.

The hull of the "Sea Call" was ruined because the steel surfaces exposed under water formed a galvanic couple with the monel-metal plating of the hull and the corrosion of the steel naturally followed. Previous examples of such corrosion from galvanic action of dissimilar metals immersed in sea water are on record in engineering literature. Less than a dozen miles away from the yard where the "Sea Call" was built is the Charles River Dam. Before that dam was built a series of experiments was made, to determine whether galvanic corrosion would result from the use of manganese-bronze truck axles on the steel gates. As a result of these experiments, zinc plates were attached to the bronze axles to protect the steel from corrosion. The use of zinc plates on naval vessels that have steel hulls and manganese-bronze propellers is well-known. The fact that nickel and iron form an active galvanic battery when immersed in a corrosive solution is illustrated by the well-known Edison storage battery.

Attention is called to these matters simply to impress upon engineers, and especially upon younger readers, the value of broad knowledge as well as specialized knowledge. It has been often remarked that many important inventions have been made by men who were unfamiliar with the technical details of the industry to which their invention applied. Their experience in other fields of work, however, enabled them to bring to the problem a range of knowledge that too often is not possessed by the specialist in the industry.

Orderly City Development

The zone, or district, system of controlling the character and use of buildings is an essential feature of modern city planning and replanning. The system is common abroad, but has scarcely gained a foothold here. It cannot make much progress in the United States without the general adoption of constitutional amendments. Such an amendment was before the New York Constitutional Convention. It read:

> The Legislature may delegate to municipalities the right to create, fix and regulate areas or districts for private residences, for the location of trades and industries, and for the protection or improvement of particular localities, and to limit and regulate the height, dimensions, kinds and uses of buildings, by districts or otherwise.

It was to be hoped that this, or some equally adequate means to the same desirable end, should have been adopted by the convention at Albany, to be approved by the voters in November and put into effect by the Legislature of 1916. Haphazard city growth is for the temporary benefit of a few property owners. Well-ordered city growth benefits all the people for all time.

Big Steamships and Economic Ocean Transportation

A dozen years or more ago there was a great deal of discussion as to the rapid increase in the size of ships and its influence on economic freight carriage at sea. About that time James J. Hill, President of the Great Northern R.R., gave a contract for the construction of two of the largest vessels ever built for freight carrying to run in Transpacific service in connection with that railroad. The end of that experiment has just been announced. One of those two huge vessels, the "Dakota," was stranded after she was put into service, and became a wreck before she could be hauled off. The other big vessel, the "Minnesota," after experiencing various vicissitudes, was continued in service and only recently was said to have transported across the Pacific the largest cargo of freight ever transported by a single ocean vessel. Notwithstanding this and the high rates for ocean freight now prevailing, it has been recently announced that the railway company has decided to retire her from service and offer her for sale.

While it is quite possible that the impending changes in the United States navigation laws may have something

to do with this decision, it is also stated that the vessel has not proved the profitable carrier that was expected. As has been frequently pointed out in these columns, the experienced ship owners of Great Britain and Germany, who doubtless understand the ocean-transportation business better than the business men of any other nation, continue to build freight vessels of moderate size in order to earn profits. It is only on the route between New York and Europe, where high-class passenger traffic is under competition, that vessels larger than 20,000 tons have ever been put in profitable service, and very few ships operated on any other route exceed 10,000 tons.

Public-Health Instruction at Ohio State University

The establishment of a department of public health and sanitation at Ohio State University is significant both in aim and in the method proposed to accomplsh the aim. The University announcement states:

> The principal object of this course is to prepare young men and women for public-health work in Ohio and elsewhere and to fit them to occupy administrative and executive positions as health officers or members of boards of health or secretaries, agents or inspectors of health organizations. It is planned to provide the scientific groundwork of sanitary knowledge which underlies efficient health administration.

The degree of master of sciencé in public health will be given after one year's study, but candidates must hold the degree of doctor of medicine or of bachelor of arts or its equivalent, and candidates with the master's degree must have had a year of preliminary collegiate training in chemistry, physics, zoölogy, comparative anatomy and pathogenic bacteriology. Most of the courses offered will be given in the Graduate School of the University. A number of the instructors appointed are members of the staff of the Ohio State Board of Health. The instructor in public health engineering is the chief engineer of that board.

The whole plan is commendable because, on the basis of either one of the required preliminary degrees mentioned, it offers specific training in the fundamental knowledge required by the modern public-health officer without adding a long course of study to that already pursued. The idea is not to turn out sanitary engineers, chemists, bacteriologists or pathologists, but rather, administrative health officers, competent to direct these and other employees of a health department. For those who wish to specialize, however, facilities are offered.

Good Bridge Paint

In 1878 a wrought-iron highway bridge was built over the Little Wabash River at Carmi, Ill., and the bridge stood until a few months ago, 37 years in all. Describing how a flood washout wrecked the bridge, G. H. Brown, the county superintendent of highways, closes his account[1] with the following laconic statement: "The iron in this structure was treated with a good coat of paint when it was erected and had another about twenty years ago."

Here is a remarkable record of paint endurance: A coat of paint lasted about twenty years. This is not a single result, but twice in succession the same experience was had—the second coat seems to have endured at least as well as the first. In view of the fact that a life of ten years is considered very good for bridge paint (the eight-year endurance of the paints in the Havre de Grace test was considered highly creditable), there ought to be no doubt that the performance of the Carmi paint is phenomenal.

A point of doubt remains, however. The first coat of paint, we know, had an ultimate life of about 17 years, but we do not know the ultimate life of the second coat. Mr. Brown does not say that it was gone. Had the bridge not been washed out, perhaps the paint would have lasted many more years—ten, or possibly even another twenty. Though the record made is so excellent, yet it may be that the flood deprived us of an even more notable record.

The work on the Brooklyn-Brighton viaduct in Cleveland (see the first page of this issue) is a typical illustration of the present high state of the art in concrete construction. Strictly speaking it is rather better than typical or average, for it has proceeded with exceptional smoothness and freedom from interruptions or complicating occurrences. It was unusually rapid and systematic. But with all due credit to the Bates & Rogers work, it can still be taken as a fair illustration of the fact that fast work in concreting is now the regular thing. We refer to a speed which not many years ago would have been out of the question. In the present case, we must remember, two bridges of 1,700 ft. are built successively, in a single season, or a total of 3,400 ft. of arch viaduct. That this is regarded as a practical or regular rate of working is indicated by the fact that at Harrisburg, Penn., the Grace contract for the Susquehanna bridge of the Cumberland Valley R.R. calls for the construction of 4,000 ft. of arch viaduct in a season.

In *Engineering News* of July 1 comment was made on an advertising leaflet issued by the University of Pittsburgh, in which a statement was made as to the average compensation of engineering graduates of twenty years' experience. Since this publication we have been informed by authorities of the University that the leaflet in question was prepared some four years ago. The figures used in its preparation were obtained from the publication of another institution and were at that time deemed to be reliable, and the statements made in the circular as to the demand from employers for graduates from the engineering course corresponded to the conditions prevailing at that time.

A number of copies of the circular were distributed through the mails at that time, in answer to requests for information, but none have been distributed since then so far as the University authorities were aware, and the recent appearance of one of the circulars, which were supposed to have been destroyed, they are at present unable to explain. Official representatives of the trustees and faculty of the University have expressed to us most emphatically their agreement with the position that misleading advertisements should not be published by any organization, least of all by an institution of learning, and assure us that the recent appearance of this circular was not authorized by the University authorities. We are glad to make this statement in justice to the University and its School of Engineering.

[1] In "Illinois Highways," the bulletin of the State Highway Department.

Letters to the Editor

The "Eastland" Disaster and Vessel Stability

Sir—The capsizing of the steamer "Eastland" in the Chicago River on July 24 has opened for discussion a technical subject about which people in general know less than nothing and about which the average engineer, unfortunately, knows but little more.

It seems to be generally supposed that a floating body rolls about its center of buoyancy, and that if the center of gravity of the body rise above the center of buoyancy,

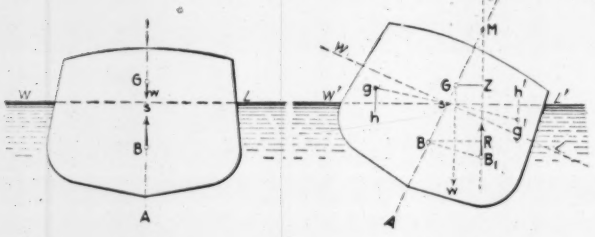


Fig. 1

Fig. 2

the body would capsize. In *Engineering News* of July 29, 1915, you state that it is an elementary principle of vessel construction that the center of gravity of the vessel as a whole must be lower than the center of buoyancy in order that the vessel may remain upright. This statement is misleading, as that condition rarely if ever exists in ships. Such a condition would produce a ship so stiff that it would be very uncomfortable to ride on and would be easily swamped in a beam sea. In fact, about the only vessel approaching this condition is the fast sailing yacht.

A floating body does not roll about its center of buoyancy nor its center of gravity. It rolls about a center known to the marine engineer as a metacenter, which is located on the axis of the ship's section at the intersection of the vertical through the center of buoyancy in an inclined position.

Referring to the accompanying sketches, Fig. 1 represents a section through a ship floating at a water line indicated by WL. The center of gravity of the ship is located at the point marked G, through which the weight of the ship W acts downward. The center of buoyant forces is at B. To satisfy conditions of equilibrium the buoyant forces must equal W and act vertically through B and G. The ship is thus in a state of rest.

Now if we consider this condition of rest to be disturbed and the ship heels over to an angle, then the condition of equilibrium no longer exists. Referring to Fig. 2, we find a new water line indicated by $W'L'$. We have taken away from the left side a buoyant wedge WSW' and added it to the right side. Indicating the volume of this wedge by v, its center of gravity by G, the total displacement of the ship by V, and the horizontal shift of the center of gravity G by hh', then the horizontal shift of the center of buoyancy from B to R would equal the volume of the wedge multiplied by the distance hh' and divided by the total displacement V; that is $BR = \frac{v \times hh'}{V}$.

The new position of the center of buoyancy is on a vertical line through R and located from B parallel to gg'. Extend the vertical through R and it will intersect the axis AS at the point M, which is the metacenter, or the center about which this ship will heel.

It will be observed that the buoyant forces acting through B no longer act through the center of gravity G and the state of equilibrium has been destroyed. The buoyant forces act to the right of G a distance indicated by GZ, known as the righting arm or lever arm, the length of which is

$$\frac{v \times hh'}{V} - BG \sin \theta$$

hence the moment of stability

$$= GZ \times W$$

$$= W\left(\frac{v \times hh'}{V} - BG \sin \theta\right)$$

It will be observed that if M is above G, a positive lever arm exists and the action of the buoyant forces is toward righting the vessel; but if G is raised to a point above M, then a negative level arm exists and the vessel will capsize.

If the stability moments are calculated for various values of θ and for various conditions of loading, curves

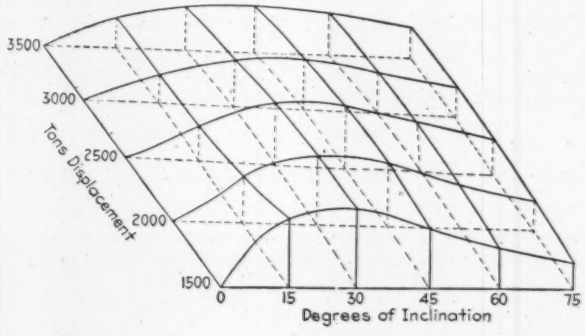


Fig. 3

may be made which will absolutely tell the story of any particular hull, such as are shown in Fig. 3.

Unfortunately the calculations involved in determining the statical stability of a ship are long and tedious and are rarely made. If the United States Government had required a complete set of such curves to be on file before the issuance of inspection papers, it is my belief that the "Eastland" would never have been placed in the excursion trade.

This ship was built for the fruit trade across Lake Michigan and for this purpose she was well fitted, her cargo being light and carried low and her speed high, as is required for the transportation of perishable cargoes.

The United States Government should not permit the reconstruction of any vessel without requiring a new set of stability calculations to be made and filed before issuing new inspection papers.

The "Eastland" was reconstructed for service that she was not fitted for at all. She was reconstructed for excursion service; some of her upper works were removed to make room for dancing. Such a cargo is necessarily carried higher, thus raising the center of gravity. This condition may be met by using water ballast, which is generally accomplished by constructing an inner bottom, the space between this and the outer shell being divided into compartments which may be filled with water. The "Eastland" was built this way. If all these compartments are only partly filled with water at the same time, then a condition of "free water in the hold" exists, and in this condition the center of buoyancy does not shift as far as it would if the compartments were full or empty. If under these conditions *B*, Fig. 2, should fall to the left of a vertical line through *G*, then a condition of negative stability would exist and the ship would capsize.

It has been suggested that the cause of the "Eastland" disaster was due to the ship being constructed without a keel. Keels do not prevent ships from capsizing. In single-bottom vessels they are used for structural purposes and in double-bottom vessels they do not exist except in the form of keelsons, which act to make the ship roll with the sea, thus making them more comfortable for passengers.

Too much emphasis cannot be placed upon the statement in your issue of July 29 that the primary cause of the "Eastland" disaster must be sought in the condition of her water-ballast tanks.

REGINALD A. TOWLER.

33 Casgrain Ave., Detroit, Mich., Aug. 2, 1915.

Mortar Beds; Brick and Granite Block Pavements

Sir—In the editorial in *Engineering News* of Aug. 5, 1915, on "Mortar Beds for Brick and Stone Pavements," you speak of the resiliency of sand cushions. Granting that a sand cushion has some resiliency, the beneficial effects, if there are any, of this resiliency are nullified by its variability and by other factors incident to proper block-pavement construction. The variability is caused by natural variation in moisture content of sand, variation in depth of cushion, in grading of sand, in depth of blocks, and in amount of compression by roller or rammer. The wedging effect of the blocks, the binding of the grout, and the crowning action of the pavement also affect the resiliency.

The fact of the matter is that no two spots on a well-constructed sand-cushion brick pavement seem to have the same degree of resiliency. The deflection of various pavements in Kansas City under a wagon-wheel load of 1500 lb. was measured by James E. Howard, formerly of the United States Bureau of Standards, with a delicate level spanning 12 in. Briefly, it was found that one-course plain concrete pavement 6 in. thick deflected 0.0002 to 0.0006 in. when tested as noted. Cement-grouted brick pavements on a 6-in. concrete foundation deflected from 0.0003 to 0.01 in., and stone blocks from 0.0003 to 0.0019 in. These limits were determined by a large number of trials in each case on a number of pavements of different ages in various parts of the city and are exclusive of trials made near manholes, cracks, expansion joints, etc. The older sand-filled brick pavements showed a much greater variation.

The point I wish to bring out is that while concrete pavement showed a very uniform deflection, the brick varied from a deflection that would indicate a support as rigid as the concrete foundation it rested on to one suspiciously like what might be expected from brick depending for support entirely on arch or wedge action.

Without repeating the many arguments for or against the plain sand cushion, it seems to me that with a properly built brick or stone pavement the term cushion is a misnomer. It is rather the *sand bed* which levels up inequalities in the base, allows slightly misshapen brick to be rolled down to a smooth surface and beds each brick uniformly. The sand bed for block pavements has performed its function with credit to itself, but engineers are beginning to recognize that its vagaries are detrimental to the pavement that must stand the severity of traffic in the present-day large city. A more perfect bedding material is obtained when cement enough to hold the sand grains in the bedding course is used. This may be placed in the same manner as the sand cushion and the blocks rolled or rammed into it before the water is added to set the cement. Such a construction will insure the maintaining of a uniform bearing for the wearing surface.

City pavements must be so constructed, in order to withstand modern traffic, that they will retain a smooth, even surface and wear uniformly. Traffic soon searches out any variation or weakness in structure. The sand-cement bedding course is an improvement over the plain sand cushion, and maintains the blocks to uniform grade with less variation. The sand-cement mixture is as resilient as the portions of a plain sand cushion that have been properly compressed and that properly bed the blocks.

CLARK R. MANDIGO,
Assistant City Engineer.

Kansas City, Mo., Aug. 28, 1915.

Sir—The editorial comment in *Engineering News* of Aug. 5 in regard to the substitution of mortar beds for sand cushions in constructing stone-block pavements expresses very fully and clearly my opinion on this subject, to which I have had occasion to refer in previous contributions on city pavements.

It is my belief, based both on experience in construction and on a study of the settled practice in the most important of the world's cities, that the modern street pavement is most successful when consisting of two elements—a solid, rigid foundation and a more or less elastic renewable wearing surface.

For the foundation, concrete is now almost universal. The wearing surface is usually one of two classes, composed either of solid rectangular blocks laid in close contact, or of a layer of mineral aggregate filled with bituminous cement.

In asphalt pavements, elasticity is provided for by an asphaltic-cement binder, and the wearing surface is laid directly on the foundation. Where there is some inherent elasticity in the blocks as in the case of wood, the pavement surface has been most successfully constructed when laid in close contact with the foundation.

That there must be some similar provision for elasticity in the case of stone-block pavements was recognized not only in Paris (as shown by your quotation) over 40 years ago, but also, to take a single other instance, in the city of Liverpool, where the first of its modern stone-block pavements was laid about 40 years ago. The method used then has been followed very closely ever since. The practice of other foreign cities, such as Hamburg, can also be cited to substantiate the statement that the general principles for successful stone-block pavements were worked out very nearly half a century ago, and that there remains very little scope within which the exploiter of new specifications can exercise his ingenuity.

In many years' experience with brick and granite-block pavements I have known of but one case where surface settlement was caused by running of the sand cushion. This was at Panama, after the fire department in an excess of zeal had spent one Sunday morning trying out the new fire hydrants, unfortunately selecting for this experiment a street in the process of paving. The result was that much of the new sand cushion found its way into the equally new sewer.

Laying granite blocks directly on a rigid foundation will not prevent such pavement depressions as are found in some of our granite-block streets, where investigation always shows an equal depression in the foundation. I know of no granite-block pavement in this country carrying denser or heavier traffic than Lafayette St., New York City, yet the condition of its surface today shows nothing upon which to base criticism of the fact that it was laid on a sand cushion.

The almost perfect surface of the stone pavements of Hamburg and the very uniform condition of those of Liverpool show success over comparatively long periods of time of the generally accepted method of stone-block pavement construction. Where the rigid foundation method has been adopted, as in the Borough of St. Pancras, London, and on certain streets in Birmingham, the method has been followed to its logical conclusion by filling the joints with cement grout, making in effect a monolithic pavement subject to the disadvantages of that type for city street surfaces. An attempt to combine the two methods by using a rigid base and an elastic joint filler would seem to give none of the advantages of either method.

One great fault of our paving construction as compared with that abroad is our tendency to spend more time on specifications than on inspection and results. In great cities abroad, specifications have only minor changes from year to year. In this country it is the ambition of each administration to adopt specifications differing from those of its predecessor, resulting in much literature but no improvement in actual conditions. Greater improvement could be obtained in our city streets by careful attention to the inspection of construction and subsequent maintenance than by any variation of the many excellent specifications which have been successfully tried out in the past dozen years.

HENRY WELLES DURHAM,
Consulting Engineer.

New York City, Aug. 20, 1915.

Sir—In connection with the Committee on Specifications under the Board of Public Service of St. Louis, I have made some study of the conditions and character of failure of vitrified brick pavements. I have also just had an opportunity of making observations on brick pavements in a number of Eastern cities and of comparing notes with other engineers, and recently I made an inspection of the brick laid on the green concrete foundation in Paris, Ill.

In the editorial on the use of mortar beds for brick and granite-block pavements, in *Engineering News* of Aug. 5, 1915, it is claimed that the sand cushion has been retained because it gives to the pavement surface a certain amount of resiliency. Now it has always seemed to me that in grouted brick and granite-block pavements this is exactly what it is impossible for the sand to do. A grouted-brick pavement is a good pavement only so long as the grouted joints are intact. If the whole paving surface acts as a sheet, it is impossible to see how the individual blocks can receive any resilient aid from the sand bed. After the grouted joints have been broken, and I believe this usually is caused by defective support from the sand cushion, the resilient action may come into play, but at the same time the pavement is practically ruined.

A close study of the vitrified-brick pavements in St. Louis has led to the conclusion that the initial failure of the pavement was caused by the varying percentages of moisture in the sand cushion as laid, resulting, on drying out, in a condition where the wearing surface is supported only at intervals. The pavement in the unsupported sections apparently breaks down, fracturing the grouted joints. The opening of the grouted joints naturally permits water to get into the sand cushion, and with the sand fairly saturated it is quite possible to imagine that the pounding of heavy loads causes a shifting of the bed, resulting in high and low spots. Every evidence of this type of failure has been found in St. Louis pavements, and the writer has observed identical conditions in Eastern cities.

From interviews with paving engineers of other cities, it is further believed that some appreciation of the action described has been the reason for the gradual reduction in many communities of the depth of sand cushion used.

During the past winter, a committee of engineers recommended, and the Board of Public Service of St. Louis adopted, a type of construction which eliminates the sand cushion entirely. Two kinds of cushions are now being tried. In one of these, limestone screenings are substituted for the sand. This material is subject to ready compacting and has high internal friction. Its use will certainly result in the improvement of brick pavements.

In the second type of construction, a 1-in. bed of 1:4 mortar is substituted for the sand cushion, and we have every reason to believe that this will entirely cure the troubles enumerated. This latter type, or something nearer the Paris, Ill., method of construction, will be used exclusively in St. Louis next year.

After visiting the work in Baltimore, Md., referred to in *Engineering News* of Aug. 5, 1915, p. 276, and inspecting actual construction, I am more convinced than ever that the mortar-bed type of construction is a long step toward the realization of efficient brick pavements. The construction of brick pavements as exemplified in Baltimore and St. Louis is simpler, and if anything involves fewer contingencies than the old class of work with the sand beds. While the ultimate results are still a matter of speculation, it seems reasonable to believe that this construction will add ten years or more to the life of brick pavements.

The laying of the brick on the green concrete foundation as exemplified in Paris, Ill., appeals to me as an ideal pavement. I was very much impressed with the smooth surface obtained by the use of a hand-roller, with the efficiency of construction, the cheapness of the pavement, and with the solid monolithic character of the finished work. If this pavement is undisturbed, its life would seem to be limited only by the wearing qualities of the brick. In large cities, however, there is one objection to this construction; that is the great difficulty in satisfactorily repairing cuts in the pavement. If this can be worked out, the Paris type of pavement is ideal.

This method of construction will also remove to a very great extent the objection to brick pavements on account of noise; for it is clearly demonstrated in the Paris pavements that, although there is a rumble from steel tires passing over brick laid on a sand cushion, there is only a slight rattle from the same vehicle on the new monolithic work.

W. W. HORNER,
Engineer in Charge of Design
of Sewerage and Paving.

St. Louis, Mo., Aug. 18, 1915.

Should Ferry Service Be Free?

Sir—In *Engineering News* of Aug. 5, 1915, Gen. H. M. Chittenden says:

> The freedom of the public highway is a freedom of use. If anyone wishes to walk or drive along it or transport goods, the public makes no charge. But the public does not undertake to transport him or his goods, except in special cases, one of which is the ferry. . . . [On the ferry] it carries the passenger and goods. The user is thus saved the expenditure of physical energy of himself and animals, wear and tear of equipment, expenditure of fuel oil, etc., in motor conveyance, over the route of the ferry. For this service, which is entirely special and in addition to that afforded by a bridge, it is right that the user should pay. He is simply paying for a service which, in the case of a bridge, he performs himself.

I submit that the distinction here set up between the road and the bridge (on the one hand) and the ferry (on the other) is wholly artificial and inconsequential and quite inadequate to justify any difference of practice as to tolls.

By building the road or the bridge or the ferry, the public spares to the user a far greater "expenditure of physical energy of himself and animals, wear and tear of equipment," etc., than by merely moving him and his goods over a small part of the line. When we have swallowed the camel by constructing the line, why strain at the gnat of merely moving persons and chattels over an insignificant portion of it?

Gen. Chittenden finds also that "ferries are special and exceptional facilities, affecting, as a rule, only limited portions of the community," and that "to make them free would thus be taxing a whole community for a special benefit to a limited portion."

But the users of the ferry (like the users of a bridge—also "a special and exceptional facility") are 100 per cent. of the users of the entire line. And probably there are members of the community who seldom or never use any part of the particular highway in question. By the same token, it would be unfair to tax these members for the benefit of those who use the highway extensively, or to tax the bachelor for the maintenance of public schools; but the bachelor (permitted to reside in a community uplifted by a public-school system) receives (cannot help receiving) in return for his taxes a value infinitely transcending the mere cost of tuition of a family of children; and since each of us is really a public servant, it is to the public's interest to facilitate our operations.

JOHN C. TRAUTWINE, JR.

257 S. 4th St., Philadelphia, Aug. 20, 1915.

Military Engineer Reservists

Sir—It is probable that every engineer is anxious to render himself serviceable to his country in assuring her integrity and safety, but this same engineer, with his deep-seated sense of economy and efficiency, cannot bring himself to see the immediate necessity of giving up an appreciable portion of his time at the most efficient period of his life to join a reserve corps and learn how to be an engineer from the viewpoint of an army officer. Or, to put it in another form, he fails to see why he is not as good an engineer without a military training as he would be were he imbued with the more or less deplorable spirit of the military caste.

Why not let the Secretary of War organize a civilian board of engineers who, acting in conjunction with the army engineers, can work out and codify the problems to be met and their solutions? The results of these researches could be recorded in suitable handbooks and thus rendered available to every engineer. The problems under war conditions should not be so much greater than under peace that the fundamentals could not be mastered in a similar manner to the standardized problems of any engineering work. With this manual available, any engineer who has had a reasonable amount of practical experience could easily master the standardized details and become a "military engineer reservist" without any trouble. Then let him signify to the proper authority his willingness to dedicate his service to the cause of his country if needed, have his name recorded with the usual formalities, and he becomes available without further trouble or expense in case of war. In this way each reservist engineer could become a nucleus about which could be gathered unlimited assistants in emergencies, and the country would have a reserve engineer corps of unparalleled magnitude.

The idea is presented for consideration with the hope that it may lead to some result that will render available to the country the brains of the combined engineering profession without the economic waste of actual military service during times of peace.

HERBERT D. MENDENHALL,
Consulting Engineer.

Jacksonville, Fla., Aug. 14, 1915.

NOTES AND QUERIES

The Paddle Wheel as a Pump is the subject of inquiry by an engineer in Fresno, Calif. He asks whether any engineer in the United States has ever constructed and utilized for raising water a scoop wheel of the type extensively used in Holland and illustrated in "Engineering News" of May 19, 1910, p. 582.

Cleaning Machines are the subject of an inquiry just received from the chief engineer of a Western railway. A machine is wanted which can be used to clean dirt, rubbish, etc., from stone-ballasted track as well as from track at stations where the ties are embedded in concrete. It is thought that some manufacturer may possibly have developed a vacuum cleaner for this special work.

New Toledo Coal Dock Built in Record Time

At the opening of navigation on the Great Lakes this spring, the Cincinnati, Hamilton & Dayton Ry. surprised its patrons with a new coal-handling plant, dock and yard at Toledo, the road's principal port on Lake Erie. While transportation was closed the old facilities in the Rossford district on the Maumee River were replaced. There is here now one of the three largest car dumpers in the country.

Yards and Dock

The work for the new coal terminal involved the construction of 802 ft. of concrete dock, concrete foundations for the unloader, approach and run-off trestles, the relaying of the load and empty yards, and the erection of the unloader frame and machinery. The new load yard has a capacity for 140 cars and the empty yard for 96 cars. South of the dock is a classification yard with a capacity for 3000 cars.

The dock, except at the unloaders, is of reinforced concrete on piles cut off 18 in. below the water line. The front line is of tongue-and-groove sheet piling. Tie rods run back from the concrete to inshore deadmen. The section at the unloader is of the same general construction except that a line of battered piles is omitted and the concrete is anchored to the machine-foundation slab.

Design of Car Dumper

Machines for picking up and dumping coal cars are ot new, but there are few the size of this one, which shows the latest practice. When the Pennsylvania, Norfolk & Western and Baltimore & Ohio roads, and other large coal shippers, proposed to increase the capacity of their cars from 50 and 75 tons to 90, it became necessary to increase the strength of the car dumpers. This machine and its two immediate predecessors were therefore built to lift a total load of 140 tons—leaving leeway to care for possible 100-ton cars with 10-per cent. overload. It is designed to dump 40 cars per hour; but up to 49 have been handled.

The cradle rail is 30 ft. above the lake level, which is higher than normally seen; this change is made to reduce to a minimum the amount of lift of cars in the machine.

The chief new feature on this machine is a disappearing mule for pushing the cars up to the dumper platform (Fig. 2). This necessitates a trough in the approach track deep enough to let the mule pass down under incoming railway cars, and a track on the bottom as well as the top. Formerly it was necessary to wait for the mule to get back into its pit before bringing in a fresh car; with this scheme cars are fed into the foot of the incline while the mule is coming down underneath them.

There are two switch gates operated by steam cylinders controlled by the reversing haulage engines so that when the engines are started hauling the mule is shifted to the upper track, and when the mule is lowered the gates on the incline are set to drop the mule upon the under track.

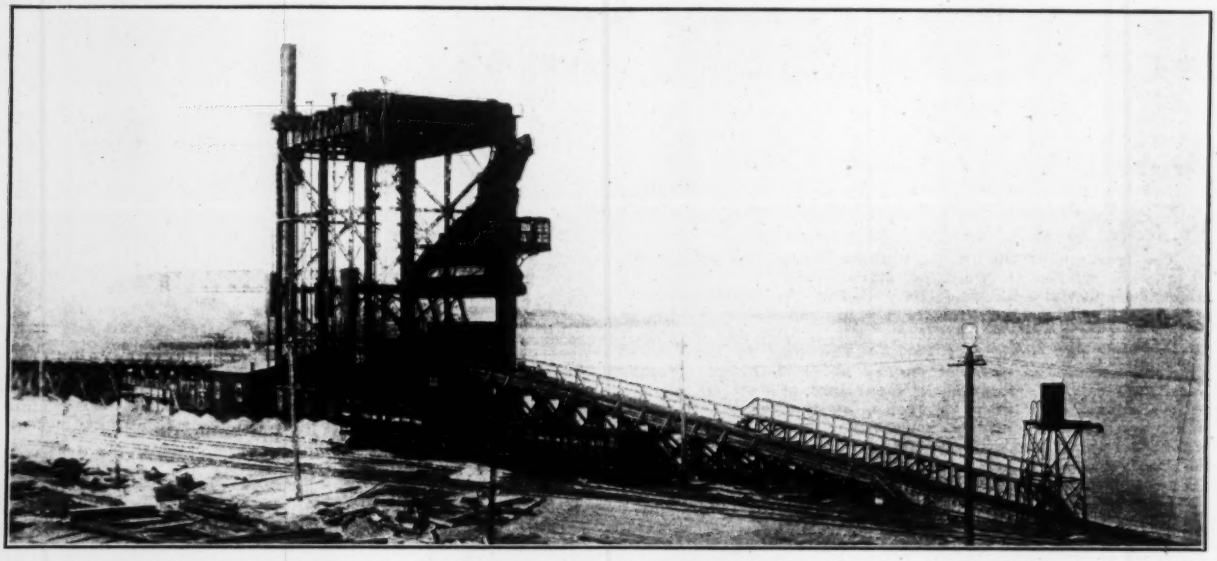


FIG. 1. THE TOLEDO COAL-CAR DUMPER OF THE CINCINNATI, HAMILTON & DAYTON RY.

To reduce the work required of the dumper boilers and engines, counterweights have been added to balance the dead-weight of the machine. There are two 50-ton boxes of iron punchings traveling up and down on the back of the dumper.

Large (22x24-in.) slow-speed engines are used on both haulage and tipple hoist. Two other engines serve the coal pan and distributing chute. Two 250-hp. internally fired Scotch marine boilers furnish steam. The machine has a revolving trimmer operated by an electric motor; otherwise all the motions are made by steam.

Operation of Dumper

The cars come down grade from a feed yard and go over the mule pit to the dumper incline, whereupon the mule rises out of the pit, comes up back of the car and pushes it up on the tipple. The platform and car are tilted sideways, the car being automatically gripped by four large clamps. The maximum inclination is 70 deg.

The coal is received on a pan which is lifted by screws to follow the car. The pan discharges into a chute and an operator on the pan directs the travel of coal to different parts of the boat. When the car is empty the cradle is returned to its original position and the upcoming loaded car pushes the empty off the platform and it runs down grade to the storage yard.

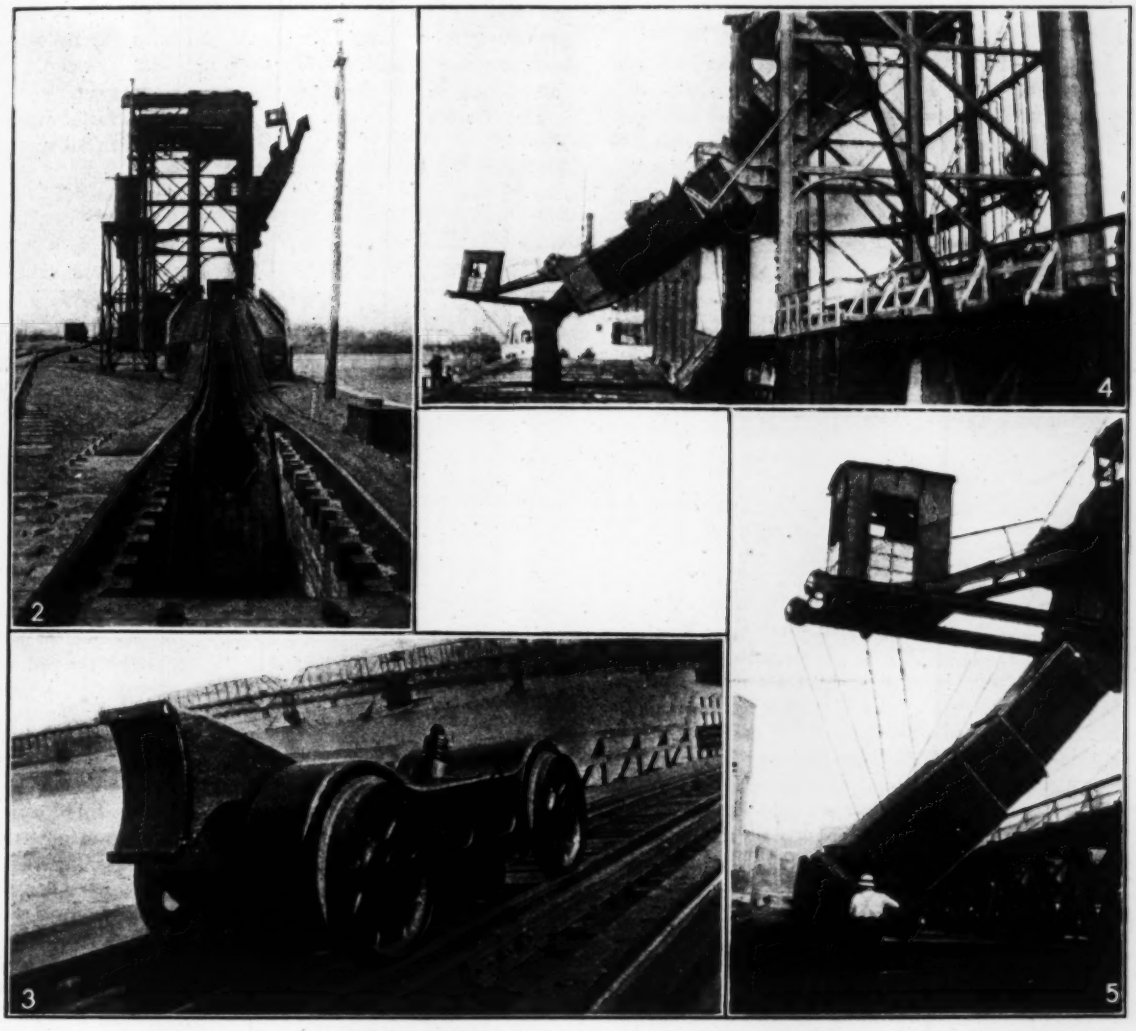
Construction and Erection

Contracts for the foundations and dock were let about Nov. 1, 1914, and preparations were rushed. The old plant was abandoned on Dec. 2 and work started the next day.

Piles in front of the old dock were driven by floating equipment, using steam hammers. Land drivers were used back of the old dock. A tug kept the river ice broken up and clear of the work. The unloader foundation was first laid and then the dock piles nearby were driven. The fill between docks was started and the pile driving pushed further along, then fill was made to the level of the concrete.

Stone and cement were brought in by rail, and sand by boat. The mixing plant was about 1000 ft. south of the car dumper and here was equipment for heating all the material. Concrete was hauled in bottom-dump buckets on narrow-gage flat cars. A boiler plant at the unloader foundations kept the concrete warm after placing, so that the weather never interrupted work. Some of the concrete was placed while the outside temperature was as low as 12 deg. below zero.

The machine foundations were completed Feb. 8, 1915. The mule-pit concrete was finished Mar. 7.



FIGS. 2 TO 5. DETAILS OF TOLEDO CAR DUMPER

Fig. 2—Mule pit and approach incline. Fig. 3—Mule. Fig. 4—Tilted car, pan and chute. Fig. 5—Chute discharging

The first structural member was set Feb. 15, and the erectors worked for a time in two shifts—early morning to noon and noon to night. In 65 working hours the main frame was ready for the riveters, who worked in four gangs in the midst of erection of other structural material. By this time the machinery began to arrive, and its installation was started along with the piping work, sheeting, glazing, etc.

The rapid erection was largely due to the way in which the material was handled. The parts were made up from

the drawings of the Cleveland and Sandusky machines, which course saved time. A schedule was in force giving the time allowed for starting each part of the construction, the time for riveting, installing machinery parts, etc. There are about 400 tons of structural material in the dumper and 350 tons of machinery.

The reconstruction of the railroad yards started Dec. 6, 1914, and was completed April 12 when the machine was ready. The new elevation was about 9 ft. above the old and the filling material was waste cinder and slag hauled to the site in standard-gage cars.

The approach and run-off trestles were erected by the substructure contractor, the material being formed nearby and handled with a locomotive crane.

The design and construction of this terminal were under the direction of F. L. Stuart, Chief Engineer, B. & O. R.R., and the work was prosecuted under the supervision of A. M. Kinsman, Engineer of Construction, W. S. Bouton, Engineer of Bridges, A. H. Griffith, Assistant Engineer, and P. Callahan, Resident Engineer.

The Smith-McCormick Co., of Easton, Penn., were the contractors for substructures and trestles. The dumper was designed, built and erected by the Wellman-Seaver-Morgan Co., of Cleveland.

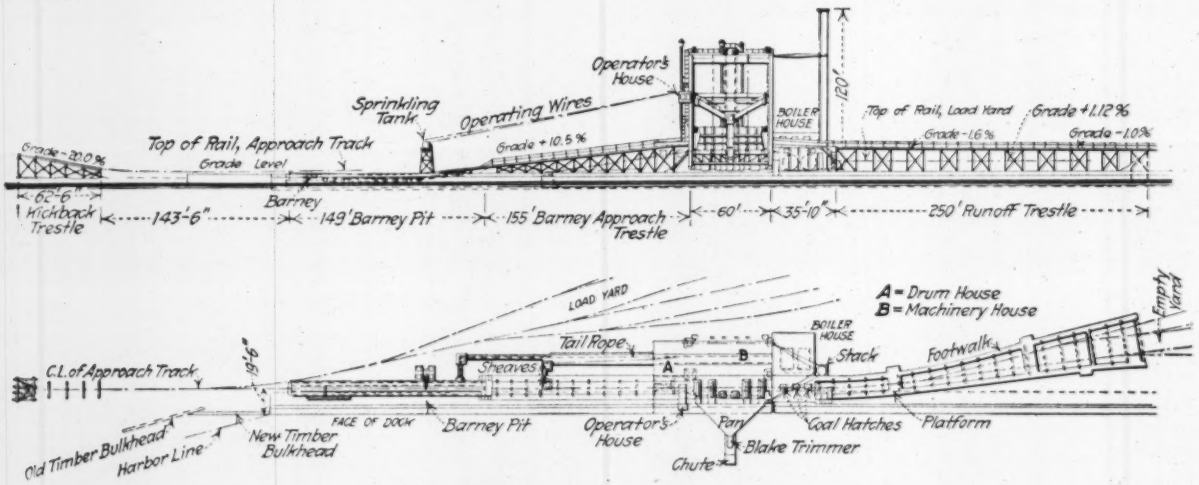


FIG. 6. PLAN AND ELEVATION OF NEW TOLEDO CAR DUMPER

The dumper was designed, built and erected by the Wellman-Seaver-Morgan Co., of Cleveland.

Galvanic Corrosion Damages Hull of Yacht

A very large new sailing yacht, the "Sea Call," built for Alexander Smith Cochrane, of Yonkers, N. Y., at a cost said to have been in the neighborhood of half a million dollars, has been so injured by corrosion, within three months after her launching, that she has been dismantled and scrapped. The case is of especial interest to engineers, as it is one of the most remarkable instances on record of serious damage resulting from the galvanic action of dissimilar metals in a structure exposed to sea water.

The yacht was intended by its owner for ocean cruising. He desired to visit out-of-the-way corners of the world where no facilities exist for dry-docking or hauling vessels out of the water to remove marine growths from the hull. It was therefore decided to build the portion of the hull under water of monel-metal plates, using steel plates, however, above the water line. Monel metal is an alloy produced and marketed by the International Nickel Co. and named in honor of Ambrose Monell, its President. It is an alloy containing about 67% nickel and 27% copper. As might be expected from these chief constituents, the metal is highly resistant to corrosion. It has a strength about equal to that of mild steel.

According to the statement of the builders, it was the original intention of the vessel's designer, William Gardner, to use monel metal for the stem of the vessel, the rudder frame and the propeller frame, as well as for the under-water plating. Some difficulty was found in producing these parts in monel metal with the necessary accuracy and freedom from warping, and it was finally determined to use steel for these pieces instead.

The framing of the hull was of steel bulb angles. Monel-metal rivets were intended to be used in all monel-metal plates. In a very few cases, however, steel rivets were used by mistake in the monel-metal under-water plating. Attention was first attracted to the serious corrosion that was going on by the failure or total disappearance of one of these steel rivets. A stream of water entering through the open rivet hole was temporarily stopped by a pine plug and later by sending down a diver who put in a steel bolt as a permanent repair. In a very few weeks, however, this bolt was also eaten away. About this time it was decided to haul the yacht out of the water to remove the marine growths that had accumulated on the hull, for it was found, contrary to the expectation of the designers, that the salt water had so little effect on the monel-metal plates that the hull rapidly accumulated enough "grass" to check the vessel's progress. The serious corrosion which had taken place on the steel parts under water was discovered when the hull was exposed to view.

The most severe corrosion took place on the thin steel rib which forms the outer frame of the rudder (the rudder itself being covered with monel-metal plates). The reason why the corrosion was so severe here was very likely because of the rapid flow of water across the rudder edge, removing the corrosion as fast as it took place and thus presenting clean metal to the action of the elec-

tric current. A similar effect, almost as severe, took place on the steel stem of the vessel. Deep pits were eaten into the steel. There was heavy corrosion also on the steel propeller-frame casting and rudder shank.

The monel metal itself, as would be expected, showed not the slightest evidence of corrosion anywhere; and had the corrosion been confined to these outer steel pieces described, they could probably have been replaced at no serious expense by similar parts of monel metal and the galvanic action thus terminated. A more serious situation, however, was presented by the interior of the vessel. It was clearly evident, from the action on these exterior steel parts, that as the interior steel framing was connected to the monel-metal plates, corrosion would be inevitable there under the action of the bilge water. The probability that this might proceed unnoticed until the vessel's structure would be seriously weakened was doubtless the consideration that led to the decision to cut up for scrap a vessel which had been launched no longer ago than last March.

The "Sea Call" was 150 ft. long on the load water line, with a length over all of 214 ft., her bow having an enormous overhang. The beam of the vessel was 33 ft. 6 in. and the draft was 18 ft. The vessel had a heavy lead keel covered with monel plates and in addition a large centerboard. It was to be equipped with a 400-hp. internal-combustion engine as auxiliary power, but the engine was never installed.

The yacht was dismantled at the yards of her builders, Geo. Lawley & Sons, at Neponset, Mass. On Tuesday, Aug. 24, the hull was hauled out of the water on the marine railway at the Lawley yards, where it was inspected by one of the editors of *Engineering News*.

The possibility of galvanic corrosion occurring had evidently suggested itself to the designers of the vessel, for we are informed that experiments extending over several months were made at the Lawley yards on plates of monel metal and steel electrically connected and immersed in sea water. These experiments, we are informed, showed no appreciable corrosion of the steel and no measurable current in the wire connecting the plates, and it was therefore deemed safe to proceed with the construction of the "Sea Call" on the lines described. The present condition of the vessel, however, is indisputable evidence that the conditions in the boat itself were entirely different from those which existed in making the experiments referred to. It is doubtless true that the area of monel metal exposed to the sea water being very large in comparison with the area of steel exposed, the corrosion of the steel was concentrated.

It seems indeed strange that some such action should not have been foreseen in view of the large amount of experience on record as to the effect of galvanic action between steel and some of the copper alloys when immersed in sea water. Monel metal, we are informed, is almost identical with manganese bronze in its electrical relation to steel when connected as a galvanic couple. In ships which use manganese-bronze propellers it has become common practice to attach plates of zinc to the hull. As the zinc is more electro-positive than the steel, the corrosion due to the galvanic action with the manganese-bronze propeller is concentrated upon the zinc and the steel is protected.

Only a few miles distant from the Neponset shipyard is the Charles River dam. On the lock gates of this dam truck axles of manganese bronze were used. In *Engineering News* of Mar. 18, 1909, Edward C. Sherman described the extensive tests which were carried on to ascertain the amount of galvanic action that would take place on steel and manganese bronze joined electrically and immersed in sea water. As a result of these tests the steel portions of the dam were protected from corrosion by wrapping zinc sheets around the bronze axles.

Minneapolis Filter Patent-Case Decision

The Jewell water-filter patent-infringement suit (Ira H. Jewell vs. City of Minneapolis) was decided for the most part against the city early in August, 1915, by the United States District Court for Minnesota, Fourth Division. The original petition alleged infringement of three patents, but was narrowed before the case came to decision by striking out one patent entirely and some of the claims of the others.

The patent stricken out of consideration was No. 649,409. This was on the combination with a filter bed of a filtered water chamber beneath the bed, with columns supporting the bed from the bottom of the chamber and means for forcing the water up from the chamber through the bed.

Patent No. 649,410, on central control of filter operation, was finally contested on claims 1, 2, 6, 7, 8 and 9. Claim 1, which was the only one allowed, read as follows:

> A filter provided with a system of controlling valves which are provided with actuating devices located so as to be accessible for control from a single position of an operator.

The city contested this claim on the ground of anticipation, alleging that the use of power-operated in place of hand-operated valves did not constitute novelty and invention, but the judge, although admitting doubt, gave the benefit of the doubt to the plaintiff. The claims denied were on a whole filter system controlled "from a single position of an operator."

The third patent at issue, No. 649,411, was pressed only as regards claim 14, as follows:

> A filter comprising a tank having a tapered lower end and an opening at the bottom of the same, a screen at the lower end of the tank in line with said opening, a granular filter-bed within said tank, the part of said bed contained within the tapered portion of the tank being made of relatively large granules whereby water passing upwardly there-through in washing the filter is laterally deflected so as to be distributed throughout all parts of the bed and a screen interposed between said larger granules and the part of the bed above the same.

This claim the court sustained, regardless of the city's claims of anticipations by Hyatt and others. Although not asserting that Jewell invented high-velocity filter washing, the judge declared that the arrangement described in the claim made such washing "a practical and efficient process."

Engineering News is informed that the screens between the gravel and sand for holding the gravel in position during the washing operation were discarded in the 12 filters of the Minneapolis plant about a year ago and that neither screens nor substitutes therefor were used in the four new filters built since the beginning of the suit.

The city will appeal from the decision on both patents.

News of the Engineering World

Old Storm Sewer Bursts

A heavy rainfall at Baltimore, Md., on Aug. 12 surcharged and burst an old storm sewer in Patterson Park, flooding a swimming pool and adjacent land. The sewer was 7 ft. in diameter, with a two-ring brick arch, and with only 12 to 18 in. of cover where the fracture occurred. The arch split and lifted along the crown for 50 ft., then settled back in place without entirely collapsing. Had the cover been deeper it is believed that the sewer would have withstood the pressure. The swimming pool was drained and closed for several days, thoroughly cleaned and again put in use.

The burst sewer was built in 1889 and, like other old storm sewers in Baltimore, was maintained by the city engineer's department. It was a branch of what is known locally as the Harris Creek drain and carried the flow of Ogiers Run. The Linwood Avenue relief drain, of 12¼x12¼-ft. horseshoe section, now nearly completed by the Baltimore Sewerage Commission, will serve this district. For the foregoing information credit is due to Calvin W. Hendrick, Chief Engineer, Baltimore Sewerage Commission.

Erie Flood Investigation

The city of Erie, Penn., has employed the engineering firm Gannett & Seelye, of Harrisburg, Penn., to investigate and report on methods of preventing serious floods in Mill Creek (see report of flood in *Engineering News*, Aug. 12, 1915, p. 326). A force of 24 engineers and surveyors is already at work making a complete topographic survey of the creek and investigating possible reservoir sites and deflection schemes in the upper watershed. At present there is every prospect that the city will go ahead with construction when the proper solution is determined upon.

New Contract for the Automatic Handling of Railway Mail

The Chicago & Alton R.R. has placed a contract for the exchange of mail between trains and stations by the automatic system of the Hupp Automatic Mail Exchange Co. This contract applies to the Chicago and St. Louis line, 284 miles, with 25 mail stations, and the equipment is expected to be ready for service within a few months.

Various automatic systems have been devised and tried at different times, with the purpose of replacing the hand-operated catcher on the mail cars and the practice of throwing mail bags from the cars by hand, but this is believed to be the first case of the use of such a system in regular service on a long stretch of line.

Mechanism on the car automatically opens and closes the door, swings out and returns the catcher, and operates the mail-delivery chute. The mechanism is put into action by a track device, or trip, as the train approaches the exchange point. The bags to be taken are hung to mail cranes in the usual manner, but any number of bags can be taken at each station. The bags delivered fall into a trough alongside the track, thus reducing the liability of damage to the mail. Both ordinary and parcel mail will be handled. An experimental plant was installed on this railway about a year ago.

Seven Hydraulic Elevators Quit

The entire passenger-elevator equipment of the Bowling Green Building, New York City, was shut down because of a pipe breakage, at noon on Sept. 3. The seven elevators were of the hydraulic type manufactured by the Otis Elevator Co., and were installed when the building was erected, about 12 years ago. The accident was caused by the breaking of a supply pipe between the storage tank and an operating valve. No one was injured.

A Wreck in Pinnacle Tunnel, Va., occurred recently, as the result of a broken rail on the outside of an 8-deg. curve, according to F. I. Cabell, Chief Engineer of the Chesapeake & Ohio Ry. The Coal River Ry., on which the tunnel is located, is a branch line of the C. & O., which connects with the main line of the latter at St. Albans, W. Va. The tunnel is 360 ft. long and except for a small portion of its length at each end is lined with timber. The alignment through it is an 8-deg. curve. A train consisting of locomotive, express car, mail-and-baggage car and three coaches was moving eastward when it struck the broken rail 90 ft. from the west portal. The rail was piped through the center of the head in such a way that it could not be detected by ordinary inspection. Fifty feet east of the point of derailment the derailed coaches knocked down 23 lin.ft. of timber lining, which allowed the timber arch and packing above to fall and crush one end of one of the coaches, resulting in serious injury to six persons.

Timber-Preserving Plants in the United States numbered 122 in 1914, according to a report just issued by the Forest Service Bureau of the Department of Agriculture. Of these plants, 100 were of the pressure-cylinder type. The returns received from three-fourths of the plants show a consumption by them last year of over 79,000,000 gal. of creosote oil and of more than 27,000,00 lb. of zinc chloride, besides 2,500,000 gal. of other preservatives, such as coal tar and crude oil. Nearly 160,000,000 cu.ft. of timber was treated, an increase of about 7,000,000 cu.ft. over 1913 and 35,000,000 cu.ft. over 1912. The rapid growth of the industry is also shown by the fact that in 1895 there were only 15 timber-preserving plants in the United States. While the largest use of timber preservation is for railway ties, the room for further growth in the industry is indicated by the fact that as yet only about 30% of the railway ties used are treated with preservative.

The Outstanding Contracts on the extensions to the New York Rapid Transit system on Aug. 1, 1915, amounted in round numbers to $160,000,000, and about 20,000 workmen are engaged. Over 60 sections are now under contract, and the remaining sections, about 20 in number, will probably be put under contract before the end of the year.

Bids for 58 Mi. of Construction Railway, in connection with the Hetch Hetchy water-supply for San Francisco, will be asked within the next two months by M. M. O'Shaughnessy, city engineer of San Francisco. The railway will extend from the Hetch Hetchy dam site to Rosasco. The estimated cost of the work is $1,800,000, and the contractor will be expected to purchase 4½ per cent. municipal bonds to cover the amount of the contract.

The Illinois Structural Engineers Licensing Law has gone into effect, and Governor Dunne on Aug. 18 appointed the Board of Examiners for Licensing Structural Engineers, as

follows: President, E. N. Layfield, 1735 Monadnock Block, Chicago; secretary, James T. Hanley, Chicago; Prof. Ira O. Baker, Urbana, Ill.; John T. Musham, Chicago; C. C. Stowell, Rockford, Ill. The regulations governing the examinations will be made public as soon as they have been formulated.

Traffic Through the Panama Canal—During its first year of operation, ending Aug. 14, 1915, the Canal passed a total of 1317 ocean-going vessels with an aggregate net tonnage, Panama Canal measurement, of 4,596,644, an average of 3490 net tons per vessel. The tolls earned were $5,216,149. In comparison the traffic through the Suez Canal for the calendar year 1914 was 4802 vessels of 19,409,495 net tons. The total receipts were 125,121,237 francs, equivalent at 19.3c. per franc to $24,148,399. There was a considerable falling off in the Suez Canal traffic in 1914 on account of the war. The traffic was, however, about 4½ times as great as that through the Panama Canal.

State-Road Maintenance in Virginia is something of a problem at this time as there has been no appropriation for this purpose for the many miles of state highways in use and under construction. State Highway Commissioner G. P. Coleman is concerned over the situation. He intends to present certain bills to the next general assembly. He recommends:

(1) That the present practice in regard to jail prisoners be corrected. The law contemplates that these prisoners shall be put on the roads, but the present tendency is to keep them in jail where they are of use only in increasing the fees of sergeants and jailors. (2) That the automobile tax be set aside for the upkeep of roads, instead of for new construction.

The Production of Explosives in the United States for 1914, exclusive of exports, according to Albert H. Fay, of the Bureau of Mines, was 450,251,489 lb., as compared with a trifle over 500,000,000 lb. for 1913. This total comprises about 206,000,000 lb. of black powder, 218,000,000 lb. of high explosives other than permissible explosives, and 25,700,000 lb. of permissible explosives. This report is the third issued by the bureau relating to the production and distribution of explosives. In 1902 only 11,300 lb. of permissible explosives was used in coal mining, whereas in the last year 19,593,892 lb. were used. The total amount of explosives used for the production of coal in 1914 was 220,622,487 lb., of which about 8.9% was of the permissible class.

To Reduce Cost of City Telephone Service—With a view to determining whether any reduction in the cost of telephone service in New York City—now amounting to $300,000 annually—can be effected without detriment to the public interest, Mayor Mitchel and Comptroller Prendergast have directed that a comprehensive study of the situation be made. The investigation will be in charge of the following committee: Putnam A. Bates, electrical engineer of the Fire Department and chief engineer of the Bureau of Fire-Alarm Telegraph, chairman; Michael R. Brennan, superintendent of telegraph of the Police Department; Robert J. McIntyre, supervising statistician and examiner, and Chester M. Gould, assistant engineer of the Department of Finance.

A Large Irrigation System in Hawaii, intended to supply fresh mountain water to the Koloa Sugar Co. on the Kauai, is nearly completed, according to an announcement by A. P. Taylor, Honolulu, dated July 30. Over 10,000 ft. of tunnel and several miles of ditches are practically finished. The Waiahole tunnel, 7 mi. long, which extends through the Koolau Range near Honolulu from the windward side of the Island of Oahu to the leeward side, is rapidly approaching completion. This tunnel was projected to carry water from the Waiahole Valley to the land of the sugar company, on the leeward side of the island. The tunnel construction is in charge of Jorgen Jorgensen, a Danish engineer, who has built large irrigation systems on the Island of Hawaii, one of which is known as the Hamakua Ditch.

The Buffalo & Susquehanna Ry., 90 miles long in western New York, was ordered to discontinue its operations by the New York Supreme Court a year ago, as noted in "Engineering News," Nov. 5, 1914, p. 945. The protest of residents along the line of the road to the State Public Service Commission caused the abandonment of the road to be delayed while various plans were canvassed for continuing its operation. It is now announced that the sale of the road will take place under foreclosure proceedings on Sept. 13, and that on that date the property will be purchased by the Western New York & Pennsylvania Traction Co., which operates a system of trolley lines in the region south of Buffalo. The new company will electrify the line and will operate passenger trains by a gasoline-motor locomotive until the electrification is completed.

Recovery of Secondary Metals in 1914, exclusive of iron and steel, was valued at $57,039,706, according to statistics compiled by J. P. Dunlop, United States Geological Survey. Secondary metals are those recovered from scrap metals, sweepings, skimmings, drosses, etc., and are so called to distinguish them from the metals derived directly from ore. The reports of the Survey do not include the large quantity of iron and steel remelted, nor do they include nickel, gold, silver and platinum. The value of the re-used iron and steel amounts to many millions of dollars annually. The recoveries of lead, zinc, copper, tin, antimony and aluminum in 1914 aggregated about 287,000 short tons. As these secondary metals sell at prices only slightly lower than those of new metals and replace an equivalent quantity of primary metals, they must be considered in any estimate of stock available for consumption in any year. Where a special purity of a metal is necessary, primary or virgin pig metal must be employed; but secondary metals are used extensively in foundries, which find this practice necessary in order to compete for business.

The Two Public Service Commissions of New York recently issued a joint order for the first time since the commissions were established. The jurisdiction of the Public Service Commission of the First District is over public utilities within the boundaries of Greater New York; that of the Commission of the Second District is over public utilities in all the rest of the state. The joint order was issued as the result of a joint meeting of the two commissions to consider the removal of grade crossings on the lines of the Harlem and the New York, New Haven & Hartford railways just south of the New York City boundary line. Improvements just north of the city limits were ordered some time ago by the Commission of the Second District. The joint order extends these improvements southward inside of the city limits. The work involves the construction of a viaduct to carry a street over the tracks, the cost of which will be apportioned according to the law, while the cost of the remainder of the work, including a new station for the Harlem company at 241st St., will be borne by the railway companies.

The Railway System of India has its most eastern extension in the new Southern Shan States Ry., lying north of Burma and Siam. This is being built to develop a rich agricultural section and to form a link in the future connection with the railway system of China. The new line opened in 1915 extends eastward from Thazi, on the Burma Railways (306 miles north of Rangoon), to Aunghban, 70 miles, and is to be carried 33 miles further to Yawnghwe. Beyond this surveys have been made as far as Feng Tung, about 270 miles further. At Thazi the elevation is 525 ft. above sea level, rising to 1546 ft. at Lebyin (38 mi.), where commences a 4 per cent. grade 17 miles long, with two switchbacks. The summit elevation is 4603 ft. and then there is a slight fall, Aunghban being at 4214 ft. Steep grades will be required to bring the line down to Yawnghwe at an elevation of 2903 ft. The railway is of meter gage. The sharpest curves are 17 deg., with transition spirals, and the heavy grades (4 and 2½ per cent.) are compensated for curvature. Locomotives of the Mallet type (0:6:6:0) are used on the heavy grades. For about 30 mi. the line is in a very unhealthy district, and a special medical force was organized. Dispensaries and hospitals were established along the work, the construction camps were visited daily, and during the fever season the doctors administered quinine regularly to all the workmen. At some points water had to be piped for several miles or brought long distances by mules. The railway was built for the Government of India by the Burma Railways Co., under the direction of F. D. Couchman, Chief Engineer, and is operated by that company.

ENGINEERING SCHOOLS

Massachusetts Institute of Technology

The contract between Harvard University and the Massachusetts Institute of Technology, under which the Harvard Engineering School was consolidated with the Institute, has been submitted to the Massachusetts Supreme Court in order that the legality of the contract may be authoritatively determined by that body. As will be remembered, an important feature of this contract is that Harvard turns over to the Institute three-fifths of the income from the Gordon McKay endowment. The trustees of the endowment, however, have filed with the court a protest alleging that under the terms of Gordon McKay's will this transfer to the Institute which Harvard Univer-

sity has agreed to make will be illegal and void. Under the terms of McKay's will, the income from the fund that he bequeathed to Harvard University will greatly increase in future years. The trustees under the will have already paid over to the University about $2,000,000, and more than $5,500,000 additional is now in the trustees' hands. The final amount of the endowment, after life interests established under the will have ceased, will exceed $22,000,000, even if all the income from the endowment is spent by the University and none is reserved for accumulation. The amount at stake therefore is very large.

The principal ground on which the trustees attack the transfer as illegal is that it is contrary to the intentions of the testator. The trustees declare that Gordon McKay during his lifetime was entirely familiar with the work of the Institute of Technology and was repeatedly solicited by persons connected with it to intrust to the Institute the management of the educational endowment he proposed to create. He, however, deliberately and intentionally selected Harvard University instead.

It is further stated that Mr. McKay was on terms of close intimacy and friendship with the late Prof. N. S. Shaler during the years from 1891 to 1906, when the latter was the head of the Lawrence Scientific School, and it was largely through Shaler's influence that McKay finally determined to make Harvard the beneficiary under his will. The trustees further declare that it was McKay's intention to have his benefaction used in promoting a wide range of scientific subjects and not be restricted to engineering and its applications, and that the Harvard University authorities cannot legally relinquish their jurisdiction over a definite proportion of this fund to the authorities of another institution.

Colorado School of Mines

The Joseph A. Holmes Chair of Safety and Efficiency Engineering has been established in this school as a memorial to the late Dr. Joseph A. Holmes, Director of the United States Bureau of Mines.

PERSONALS

Mr. O. H. Lang has been appointed Engineer of Highways of Thomas County, Georgia, with headquarters at Thomasville.

Mr. William B. Bamdford, M. Am. Soc. C. E., Architect and Consulting Engineer, of Belmar, N. J., has been elected a member of the City Council of Belmar.

Mr. N. Everett Waddell, Assoc. M. Am. Soc. C. E., will hereafter be associated with his father, Mr. J. A. L. Waddell, M. Am. Soc C. E., in partnership under the firm name of Waddell & Son, Consulting Engineers, 800 Graphic Arts Building, Kansas City, Mo.

Mr. R. T. Childs has resigned as Editor of the construction news department of "Engineering News," to take charge of an important real-estate development at Mineola, Long Island. His New York office address is 358 Fifth Ave., Shawmut Realty Co. He is a civil-engineering graduate of Rensselaer Polytechnic Institute, class of 1903, and was formerly a member of the editorial staff of "Iron Age." He has been with "Engineering News" since December, 1909, and he originally established the department of market prices of engineering materials, appearing in the first issue of each month. Mr. L. V. Fletcher, as head of the business news department of the Hill Publishing Co., has assumed Mr. Childs' work. He has been with the F. W. Dodge Co. construction report agency for 10 years, for five years being in charge of the news-gathering service of the eastern office.

OBITUARY

Samuel Todd Davis, Jr., President of the Locomobile Co., of Bridgeport, Conn., died at Fairfield, Conn., on Sept. 1, in his 43rd year.

William John Noonan, for 20 years a member of the Ottawa River Works Department, and later engineer for the City of Ottawa, Ont., died recently at his home in that city from pneumonia.

Thomas W. Burrows, formerly General Superintendent of the old Chicago & Erie R.R., died at his home in Lima, Ohio, on Aug. 30, at 63 years of age. He was engaged in railway work most of his lifetime.

Alexander Wilson, formerly Superintendent of the Railroad Department of the Cambria Steel Co., died at Johnstown, Penn., on Aug. 30. He had served as Mayor and Comptroller of Johnstown. He was 75 years old.

E. F. McCrea, Division Engineer of the Cleveland & Pittsburgh division of the Pennsylvania Lines, died on Aug. 28 at his father's home near Logansport, Ind. Mr. McCrea had been in the Pennsylvania's service since 1899.

James W. Cain, formerly Superintendent of Highways of the Borough of Queens, Long Island, died at his home in Bayside, L. I., on Aug. 27, at 70 years of age. Mr. Cain was a resident of Bayside nearly all of his life and was widely known in political circles in Queens.

Griffith W. Lewis, State Director of Railroads of New Jersey, died suddenly from heart trouble at his home in Burlington, N. J., on Aug. 28, at 51 years of age. He served in the State Senate in 1910 and for many years was identified with Republican affairs in Burlington County.

I. N. Robinson, Road Overseer of Ouray County, Colorado, was instantly killed in an automobile accident on Aug. 24. He was on his way to Portland to inspect a bridge which was being constructed there across the Uncompahgre River. His son, who accompanied him, was seriously injured.

J. W. Harry James, a civil and mechanical engineer, of the American Bridge Co., of Wilmington, Del., died at his home in Chester, Penn., on Aug. 28. He was born in England, and prior to his residence in this country had charge of various engineering works in England, France and Russia. He was at one time Consulting Engineer of the Department of Public Works of India.

John R. Graham, President of the Bangor (Me.) Railway & Electric Co., died on Aug. 24 at Intervale, N. H., while on vacation. For many years Mr. Graham was a resident of Quincy, Mass., until about 10 years ago, when he moved to Bangor, and was well known in railway affairs in both cities. At one time he was President of the old Boston & Quincy Railway Co. He was 68 years of age and 10 children survive him.

Gen. John H. Albin, of New Hampshire, President of the Connecticut River R.R., died recently. He was a graduate of Dartmouth College and practiced law in the State of New Hampshire the greater part of his lifetime. For many years General Albin was a Director and President of the Sullivan County R.R., in the Connecticut Valley, and was also a Director of the Vermont Valley R.R., and a Director and President of the Concord Street Ry. He was a Director of the Connecticut River R.R. and in 1914 was elected President, to succeed the late Lucius Tuttle.

John Haines Warder, Assoc. Am. Soc. C. E., Secretary of the Western Society of Engineers, died at his home in Chicago on Aug. 30, at 70 years of age. Mr. Warder was a graduate in mechanical engineering of the Polytechnic College of Philadelphia, and was engaged in engineering work the most of his lifetime. At one time he was connected with the Cincinnati Southern Railway System and was engaged in bridge inspection at various times at the Phœnix Iron Works and in the cites of Detroit, Pittsburgh, Edgemoore, Minn., Athens, Penn., Elmira, Rochester and Chicago. He also had much to do with planning the power and electric plants of Chicago. At the time of his death he was Assistant Engineer of the Bureau of Sewers of that city. He had been Secretary of the Western Society since January, 1901.

William L. Ziegler, Engineer of Construction of the Pennsylvania R.R., died Aug. 6. He was born in Harrisburg, Penn., Aug. 15, 1847, and graduated from the Central High School Philadelphia, in 1865. He joined the engineering corps of the

Pennsylvania R.R. two years later as a chainman. Having served as rodman, levelman and transitman, he was promoted to be Assistant Engineer in 1873. In 1875 he was appointed Assistant Engineer of Maintenance-of-Way, in charge of the construction of the tracks and station in Fairmount Park to take care of the Centennial traffic in 1876. Afterward he became Engineer of Construction in charge of the union station and carsheds at Pittsburgh. In recent years he had charge of the construction of some of the most important improvements made by the railway company in Philadelphia.

J. G. Metcalfe, formerly President of the Mexican International Ry., and recently consulting railway expert for Speyer & Co., bankers, of New York City, died at Pocono Summit, Penn., on Aug. 31, in his 67th year. Mr. Metcalfe was born in Cambridge, Ohio, and started his railway career as a telegraph operator. In 1900 he was made General Manager of the Denver & Rio Grande R.R., and later held the same position on the Evansville & Terre Haute R.R. In 1902 he was appointed President of the Mexico International Ry., and for a year, starting in 1904, was Vice-President of the National Lines of Mexico. In 1905 he became Vice-President of the Manila Railway Co., and retained that position until his death, at which time he was also Vice-President of the Bolivia Railway Co. and a Director of the Missouri Pacific R.R. He took an active part in solving transportation problems in South America, and some years ago was called to London to give expert advice on the London Underground Railway Co.'s problems.

ENGINEERING SOCIETIES

COMING MEETINGS

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 7-9. Convention in New York City. Secy., Willard Kent, Narragansett Pier, R. I.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 7-10. Annual meeting in Chicago. Secy., W. O. Thompson, N. Y. C. R.R., East Buffalo, N. Y.

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

SAN FRANCISCO MEETINGS

INSTITUTE OF RADIO ENGINEERS.
Sept. 13-18. Secy., David Sarnoff, 71 Broadway, New York.

PAN-AMERICAN ROAD CONGRESS.
Sept. 13-18. Secy., E. L. Powers, Road Builders Association, 150 Nassau St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 16-18. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Sept. 16-18. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Sept. 16-18. Secy., Bradley Stoughton, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Sept. 16-18. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Sept. 16-18. Secy., J. J. Blackmore, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 16-18. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

NATIONAL DRAINAGE CONGRESS.
Sept. 17-21,

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H Ross, 154 Nassau St., New York City

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J F. Nickerson, 431 South Dearborn St., Chicago, Ill

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30. A. C. Carruthers, Vice-Pres., Collective Insurance & Universal Safety Exhibit, Mines and Metallurgy Bldg., San Francisco.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

County Highway Engineers' Association—The ninth annual session will be held at Hannibal, Mo., Sept. 13-15. The secretary is E. W. Sheets.

Pennsylvania Welfare and Efficiency Congress—The third annual conference will be held in Harrisburg, Penn., Nov. 16 to 18, and the annual exhibit Nov. 15 to 19.

Engineers Club of St. Louis—A reunion meeting was held at the club on Sept. 8, at which several of the members gave their impressions of the Panama-Pacific Exposition.

American Institute of Consulting Engineers—The Institute has recently joined the Chamber of Commerce of the United States and claims that it is the only engineering organization which has membership in that body.

Youngstown Engineers' Society—The Youngstown (Ohio) engineers will hold a picnic at Milton Dam on Saturday, Sept. 11. The trip to the dam will be made in automobiles. The Milton reservoir is situated 17 mi. west of Youngstown. Its capacity is 10 billion gallons, length 6 mi., greatest width 1½ mi., depth of water at spillway 46 ft. The earth-fill dam contains 200,000 cu.yd. The secretary is L. P. Fawcett.

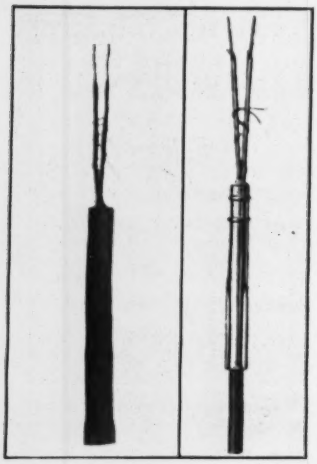
Canadian Engineers representing the British Columbia and Alberta members of the British Institution of Civil Engineers, the Canadian Society of Civil Engineers and the American Society of Civil Engineers have made arrangements with the Southern Pacific and the Canadian Pacific Ry. companies for special train and steamer facilities from San Francisco via Victoria and Vancouver and Calgary to Chicago in order that the members of the International Engineering Congress may have an opportunity to view the Canadian Rockies and to visit some of the engineering works along this route. C. W. Allen, engineer of the Dominion Water-Power Branch, in charge of the water-power exhibit in the Canadian pavilon at the Panama-Pacific International Exposition, has arranged to make the final preparations for the trip, and requests for information should be addressed to him.

National Conference on Concrete Roadbuilding—The second national conference will be held in Chicago, Sept. 15 to 18, at the Auditorium Hotel. The following subcommittees will report: Drainage and Preparation of Subgrade, Hector J. Hughes; Economical Widths of Pavement and Shoulders, J. J. Cox; Problems of Design, Thickness, Crown and Grade, Ira O. Baker; Aggregates, D. A. Abrams; Handling and Hauling Materials and Water-Supply, T. R. Agg; Organization of Concreting Crew, H. P. Gillette; Proportions of Materials and Consistency of Concrete, W. S. Gearhart; Mixing and Placing Concrete, Ernest McCullough; Reinforcement, Richard L. Humphrey; Joint Location and Construction, George A. Ricker; Expansion and Contraction, F. E. Turneaure; Finishing and Curbing, Charles Whiting Baker; Construction of Shoulders and Curbs, A. N. Johnson; Methods and Cost of Maintenance, A. H. Hinkle. Form of Specifications, A. R. Hirst; Cost of Construction, C. J. Benett; Estimating and Inspection Problems, A. Marston. The office of the secretary is at 208 South La Salle St., Chicago.

Appliances and Materials

Delay Electric Detonators

Two detonators for use in tunnel driving, shaft sinking, etc., which will set off the various charges of explosives as desired by one operation of a blasting machine or one application of electric current, are now manufactured by the E. I. du Pont de Nemours Powder Co. One is called the "du Pont Delay Electric Blasting Cap" and the other the "Delay Electric Igniter." They differ in construction, but have the same purpose. The caps are made with two delays, and are similar in outward appearance to the ordinary electric blasting caps, except that the copper shells are slightly longer and are covered with a rubber tube. The delay is accomplished by the use of a slow-burning material inside the shell, which is ignited by the electric current passing through the bridge wires. When this material has burned to the fulminate charge in the shell, the latter explodes and in turn detonates the explosive. In use the instantaneous electric blasting caps are placed in the hole or set of holes which should be detonated first and simultaneously; the first delays are placed in the hole which should be detonated second; the second delays are placed in the holes to be detonated third. Ordinary electric blasting caps can be used in dry work, but in wet work the waterproof electric blasting caps should be used in connection with the delay electric blasting caps, the latter being made on the waterproof type.



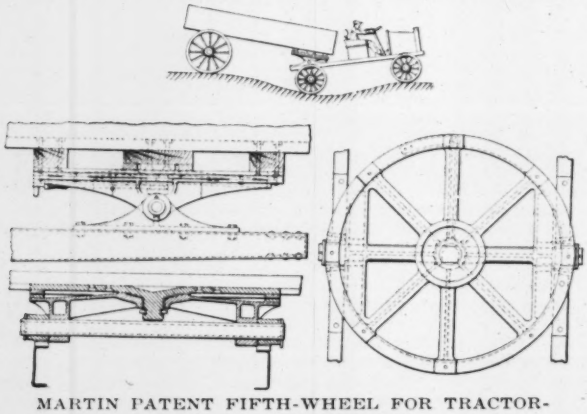
DELAY ELECTRIC BLASTING CAP AND DELAY ELECTRIC IGNITER

The delay electric igniter is made with a number of delays. It consists of a small brass tube, into one end of which the igniting material, composition plugs and wires, are inserted and fastened. These extend about half the length of the tube. Into the other end is inserted a piece of fuse, which touches the igniting material and which is clinched securely in the brass tube. The delay is brought about by using different lengths of fuse, the first delay having 2 in. of fuse, the second 4 in., etc., the fuse length increasing 2 in. for each delay. The wire lengths are the same as for the regular electric blasting caps.

* * *

Flexible Fifth-Wheel for Tractor-Trailer

A fifth-wheel attachment with unusual features, an appliance designed to convert any motor truck into a tractor for handling a two-wheel trailer, has been put on the market by C. H. Martin, 293 Bridge St., Springfield, Mass. This fifth-wheel connection, as the accompanying sketch shows, has a crosswise hinge which gives longitudinal flexibility, thus permitting the vehicle as a whole to conform to the unevenness of the road. No longitudinal hinge is provided, for the reason, it is claimed, that this would permit sidewise tipping of the load on curves or on a crowned road, and thus interfere with the stability of the vehicle. The Martin patent fifth-wheel is made of steel in several sizes from an 18-in. circle for Ford cars or light runabouts ($25) to a 36-in. circle for 5-ton trucks ($90). The top member may be bolted to the cross-bolsters of any wagon and the lower member to the frame of any truck.

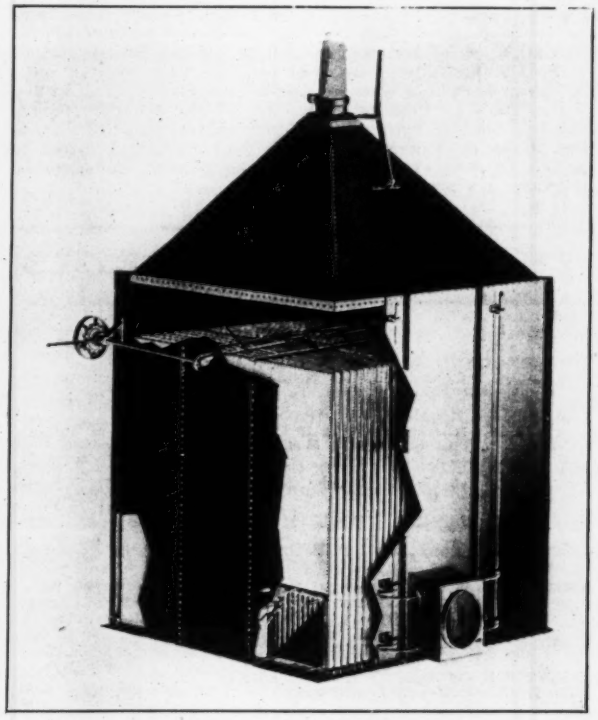


MARTIN PATENT FIFTH-WHEEL FOR TRACTOR-TRAILER CONNECTION

* * *

Cloth-Screen Dust Arrester

A device for collecting dust from tumbling mills, emery wheels, sand-blast equipment, etc., was recently placed on the market by the Whiting Foundry Equipment Co., Harvey, Ill.



CLOTH-SCREEN DUST ARRESTER

The makeup of the arrester is shown in the accompanying view. It consists of an outside case or house of heavy sheet steel in which is located a series of cloth screens that permit free air passage. Air which has passed through this arrester is claimed to be entirely satisfactory to breathe.

* * *

Automatic Gas Street Lamps

An automatic gas lighter has been devised by the Automatic Gas Lighting Equipment Co., of Boston, Mass. This is intended to take the place of the men and boys who are universally employed for lighting and extinguishing gas street lamps. A clock box is attached to the Welsbach lamp standard and the clock mechanism in it operates a tripping lever controlling a double-acting valve. When the gas supply is open the pilot supply is closed, and vice versa. The pilot comes up through a small hole in the center of the gas cap and the flame may be adjusted to use 0.1 or 0.2 cu.ft. per hr. The lighting and extinguishing times are regulated by a control dial inside the clock box.

This device has been used in Newton, Fall River, Gardner and Quincy, Mass., and other cities in from 100 to 1000 units. It is claimed that one man can easily look after 250 to 300 of these machines and lamps, doing all the inspection, cleaning, winding, replacing of mantles, etc. It is claimed that the cost of running a lamp so equipped, including labor, mantles, chimneys, globes, domes, clock repairs, depreciation and interest at 10 per cent., totals about $6 per annum, which is to be added to the local cost of gas, which may vary from $9 to $12. The cost of street lighting where hand extinguishment and lighting is employed is in the vicinity of from $24 to $30 per annum.

Engineering News

VOLUME 74 SEPTEMBER 16, 1915 NUMBER 12

Building the Mathis Dams--I

By E. Lauchli*

SYNOPSIS—First of two articles on the storage reservoir and dams of the Georgia Ry. & Power Co., supplementing earlier notes on the Tallulah Falls high-head hydro-electric development. Design of a reinforced-concrete dam with bulkhead, spillway and power-house sections. Unusual grouting of deep-lying fissured rock to prevent leakage.

The two reinforced-concrete dams at the Mathis storage reservoir of the Georgia Ry. & Power Co.'s Tallulah Falls development[1] are of unusual interest because of their features of design and methods of construction. A few brief notes on both aspects of the work are given herewith.

The Mathis reservoir is 10 mi. long and has a storage capacity of 1,335,000 cu.ft. It is located at Lakemont, Ga., some 6 mi. above the intake works of the Tallulah Falls plant. In order to dam the Tallulah River, it was necessary to throw across it a reinforced dam, 660 ft. long and 90 ft. high; and to close a depression leading out of the basin, a reinforced-concrete dam, 325 ft. long and 45 ft. high, was built a quarter of a mile downstream from the main dam. The location of both these structures is shown in Fig. 2.

The main dam comprises a short bulkhead section (east end), followed by a 290-ft. spillway section, then by a 60-ft. intake or power-house section, and finally by

*2 Wall St., New York City.

[1]For the design of the Tallulah Falls hydro-electric plant see "Engineering News," Jan. 29, 1914; for notes on construction difficulties see the issue of Apr. 16, 1914.

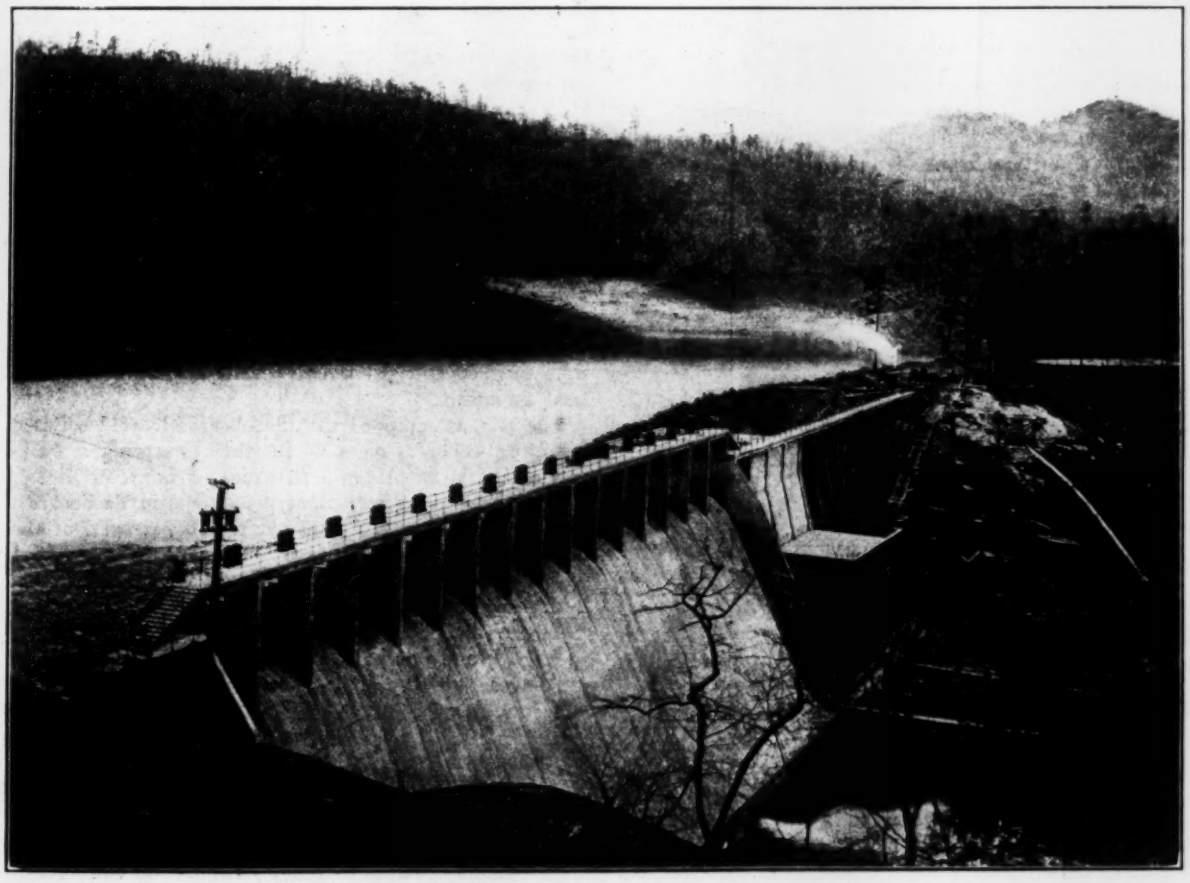


FIG. 1. REINFORCED-CONCRETE DAM AT MATHIS RESERVOIR

a second bulkhead section ending in a corewall carried into the hillside.

The spillway section consists of reinforced-concrete buttresses, 18 ft. c. to c., carrying upstream arched decks on a slope of 45 deg. with the horizontal, and aprons

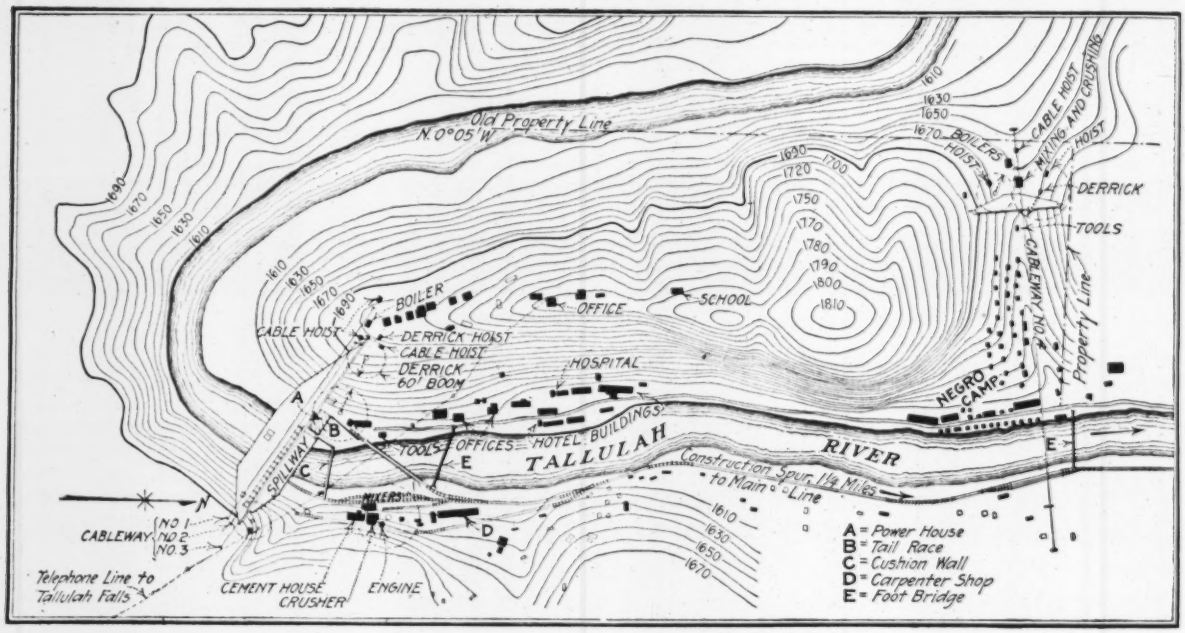


FIG. 2. CONSTRUCTION LAYOUT FOR THE MATHIS DAMS

on the downstream side, as shown in Fig. 3. The buttresses, to save material, were built in 12-ft. lifts, and decrease in thickness from bottom to top, and from the upstream to the downstream end. For instance, the lower lift of a buttress tapers from 40 to 32 in. and the upper lift from 24 to 20 in.

The spillway buttresses are reinforced horizontally at lift elevation and vertically at cross-strut points. Two walkways are provided through the buttresses, one near

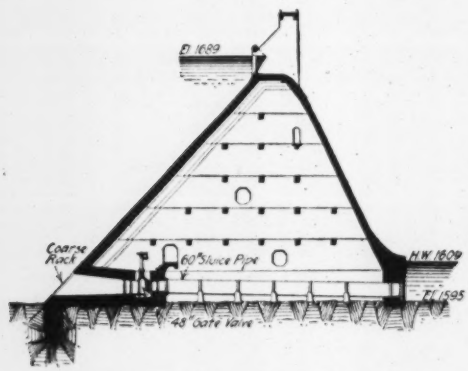


FIG. 3. SLUICEWAY SECTION, MATHIS DAMS

El. 1610, leading from the power house to the gate valves of the sluiceways, and one at El. 1655.

Decks, Aprons, Crest and Sluice

The decks consist of reinforced-concrete arched slabs, free to expand or contract horizontally. They have a rise of 18 in. at the crown and a crown thickness varying from 18 in. near the crest to 39 in. at the bottom, near the cutoff wall. The reinforcement is of 1⅛-in. corrugated bars placed 4 in. c. to c. at the bottom, the spacing varying at higher elevations according to the load carried. Near the crest the reinforcement is of 1-in. rods. Equalizing rods of ⅝-in. diameter are laid longitudinally, 24 in. c. to c. The decks were built in lifts corresponding to the buttress lifts, and keys were provided at the joints. Each deck rests on reinforced haunches cast with the buttress. To allow expansion and to insure imperviousness $\frac{3}{16}$x6-in. hair-felt strips were laid in hot asphalt at the seat, between the decks and the haunches.

The aprons on the downstream side are 18 in. thick from top to bottom, reinforced with 1-in. rods, spaced 7 in. c. to c., with equalizing rods running longitudinally. No waterproofing was provided between the apron slabs and the buttresses, but the abutting surfaces of each slab were tongued and grooved to permit horizontal and vertical expansion.

The crest is equipped with flashboards located between reinforced-concrete piers 26 in. thick, carrying a walkway or operating bridge 8 ft. wide, as shown in Fig. 5. There are seven Stauwerke-type automatic flashboards, capable of discharging 6000 sec.ft. (50 per cent. of the maximum recorded discharge) and nine hand-operated flashboards. All consist of leaves 16 ft. long and 7 ft. high, hinged at the crest of the dam.

There are three sluiceways, two at El. 1601, as shown in Fig. 4, and one at El. 1643, having a total capacity of 3500 sec.ft. with the pond at maximum elevation. Each sluiceway consists of (1) a tapered reinforced-concrete intake, protected by a coarse rack made of 35-lb. rails, 14 in. c. to c.; (2) a 48-in. gate valve operated by a 7-hp. electric motor, controlled from the power house; and (3) a 60-in. steel pipe ⅜ in. thick, carried on concrete piers.

The gate valves are of heavy design, with square bottom disks and heavy bronze guides. Heavy flaring cast-

ings, embedded in heavy concrete blocks, are provided on either side of the gate valve.

In order to protect the river bed from erosion, on the downstream side of the dam, a concrete submerged weir has been provided 100 ft. downstream from the spillway section, so as to form a water cushion, 14 ft. deep, in times of heavy floods. The weir wall, 3 ft. wide at the top, 7 ft. at the base, and 3.5-ft. high, is designed to

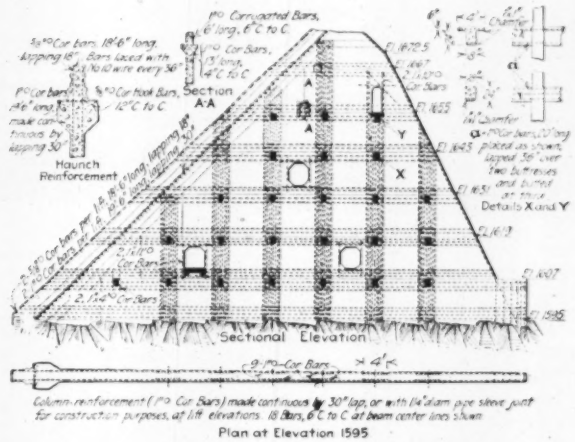


FIG. 4. SPILLWAY BUTTRESS DESIGN

have a low discharge coefficient. It is built on rock foundation throughout, and anchored every 18 in. with 1-in. rods.

Power-House Section

The power-house section of the dam is shown in Fig. 6. It consists of three bays, between buttresses spaced 20 ft. c. to c. Provision has been made for two 3000-kw. units. The power house is a brick building with steel columns on the downstream side, carrying the roof beams and the crane girders, the latter being carried at the upstream side of the power house on concrete brackets. The foundations and wheel-pits are of mass concrete.

There are two intake bays, each provided with stop-logs, fine-trash racks and 14x14-ft. steel headgates, with bronze guides, operated from a concrete platform at El. 1692. An 18-in. bypass has also been provided on each penstock to balance the pressure before hoisting the gate.

The bulkhead section consists of buttresses, of uniform thickness throughout a lift, placed 18 ft. c. to c. and without aprons on the downstream side, as shown in Fig. 1. The buttress footings were carried down to rock, with the exception of a few buttresses at the west end, which, on account of the extreme depth of bedrock, were given spread footings.

Throughout the dam a concrete cutoff wall was carried down to rock at the upstream side. Before laying concrete in the cutoff trench, drill-holes were put down

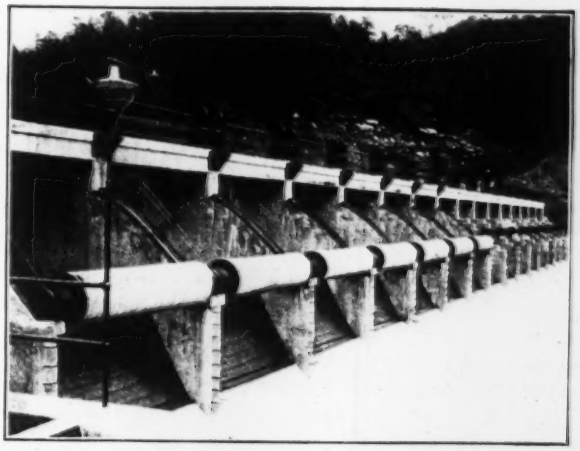


FIG. 5. AUTOMATIC FLASHBOARDS AT MATHIS DAM

at the bottom of the trench and then grouted under pressure.

In general these holes took little grout, except at the west end of the dam, where some trouble was experienced on account of the geological formation of the hill. Here the cutoff wall was carried down as far as 30 ft. below the original ground surface (see Fig. 7). From there on, to and beyond the dam, Lackawanna steel sheet piling 30 ft. long was driven through the material overlying the rock.

Grouting Fissured Rock

The location of the rock had been ascertained by driving 4-in. steel pipes (with water jet and by churning). In general it was found that the underlying rock was badly fissured and weathered. As there was some possibility that leaks would develop, about 3300 ft. of holes, 10 to 30 ft. deep, were put down with steam and air

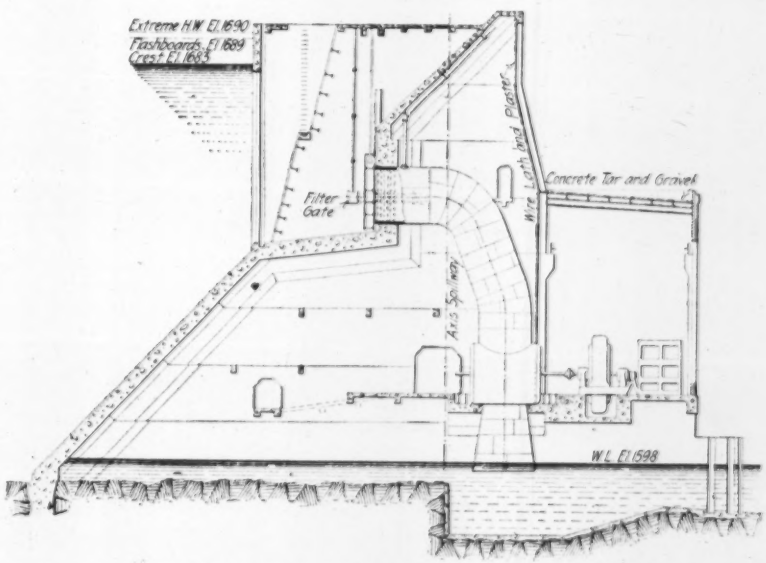


FIG. 6. SECTION THROUGH MATHIS DAM AT POWER HOUSE

drills and then grouted under 60- to 90-lb. pressure. About 2300 sacks of cement were thus used with a little sand added when the grout was absorbed too freely.

This, however, was not considered sufficient, as there was always the chance that a vertical hole would miss vertical seams. Therefore a shaft 50 ft. deep was sunk

at the west end of the dam, on the downstream side. As it was anticipated that drilling and grouting would be carried on while the reservoir was filling up, the bracing and sheeting was made strong enough to resist the full hydrostatic pressure. The shaft was driven through soft material easily picked for the first 40 ft. Below this elevation blasting had to be resorted to in order to excavate a working chamber 8x17x8 ft. The shaft was made 6x8 ft. in the clear and timbered with 10x10-in. posts and caps and 3-in. sheeting. The voids beyond the lagging were grouted. Diamond-drill holes varying in length from 50 to 290 ft. were put down at various angles, as shown in Fig. 7.

Some 1400 ft. of 4-in. holes were drilled, the bits giving a 3-in. core. Progress varied from 10 to 30 ft. per 24 hr. (two shifts), according to the hardness of the material penetrated. Frequently during drilling a flow of 3 or 4 gal. per min. would spout out of the collar of a hole, but no serious inrush of water ever occurred.

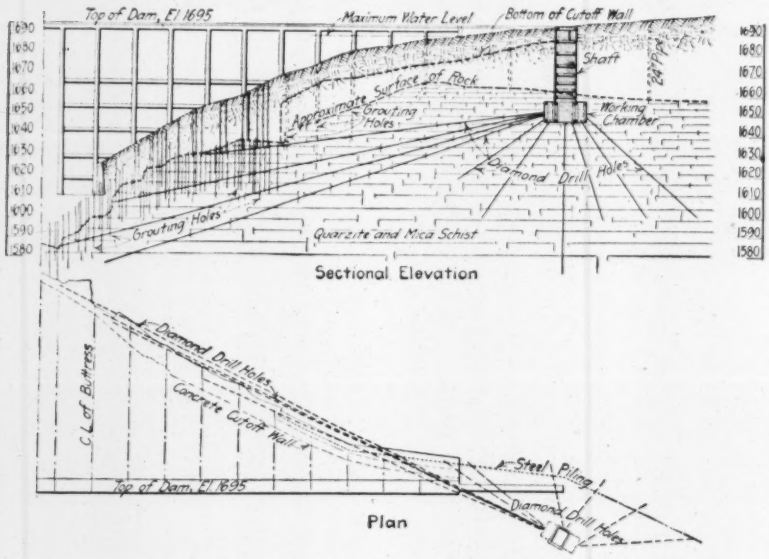


FIG. 7. DIAMOND DRILL HOLES FOR GROUTING FISSURED ROCK

With the reservoir at maximum elevation the total leakage into the shaft never exceeded 10 gal. per min. No bits or diamonds were lost. This work was done at a cost of about $4.50 per lin.ft. for drilling.

The holes were grouted under a pressure of from 60 to 80 lb. per sq.in. with neat cement grout mostly. Usually a hole would be drilled a short distance, and then grouted, then cleaned out and redrilled. A cement core could be recovered after 20 hr. when the hole was not cleaned out. About 29,000 gal. of grout was forced into the holes, the upper part of these absorbing more than the lower.

The total leakage at the west end of the dam never exceeded 200 gal. per min. with the reservoir at maximum elevation; it was finally reduced to a negligible amount.

Concrete Proportions and Stresses

The buttresses, piers and abutments were made of 1:3:6 concrete, the stone passing through 2½-in. mesh. The decks, crest, apron, beams and bridges were made of 1:2:4 mix, the stone passing a 2-in. mesh. The steel for the reinforcement had an ultimate strength of not less than 80,000 lb. per sq.in.

The following unit stresses were allowed:

	Tons per Sq.Ft.
Bearing power of rock for buttress footings	15
Bearing power of hardpan	3
	Lb. per Sq.In.
Buttresses, compression	300
Buttresses, direct shear	100
Deck and apron, compression	600
Deck and apron, tension	0
Deck and apron, shear	75
Steel reinforcement, tension	14,000

The structure required 23,700 cu.yd. of excavation; 33,600 cu.yd. of concrete and 1,908,200 lb. of steel reinforcement—about 56 lb. of steel per cubic yard—were used. The largest amount of concrete laid per week was 1073 cu.yd., and the largest weight of steel 87,400 lb.

Engineers and Contractors

The writer was in charge of the design of this dam and supervised its construction. C. G. Adsit was in general charge of construction work at the Mathis reservoir; with H. T. Hartwell as resident engineer. The late John Birkinbine was retained as consulting engineer. The whole Tallulah River development of the Georgia Ry. & Power Co. was designed by C. O. Lenz, Chief Engineer.

Gasoline Made by New Process

Much has been heard in recent months of processes for the production of gasoline fuel for internal-combustion engines out of heavier petroleum oils. Most of these processes seem to be modifications of the fundamental scheme to "crack" the heavier oils into the more volatile hydrocarbons with the deposition of excess carbon in the treating retorts. One process (described by the inventor, A. M. McAfee, before the American Institute of Chemical Engineers in San Francisco, Aug. 25, 1915) differs radically from these others in that high pressure is not employed on the stills and high-boiling oils are broken down into lower-boiling oils, which are sweet-smelling, water-white and saturated for hydrogen. Valuable heavy oils are produced as desired, and the carbon is deposited in a granular mass easily handled. The process has been tried out with success by the Gulf Refining Co., of Bayonne, N. J.

In practical operation, any kind of crude petroleum is distilled to remove gasoline and kerosene or to free it of moisture. Anhydrous aluminum chloride is added, and the mixture is brought up to boiling in a still with stirrer. The distilling vapors are held to 350° F. or under, to prevent the aluminum chloride passing over to the condenser. The distillate is a mixture of gasoline, solvent oil and kerosene which are later separated by fractionation. No treatment is given them except washing with alkali.

The results with a Texas crude oil show 17.8% gasoline, 13% gas naphtha, 8.7% kerosene, 17.1% gas oil, 25.6% lubricating oil, no asphaltic residue and a loss of 17.8%. The usual process yields 4.3% kerosene, 52% gas oil, 25.5% lubricating oil, and 12½% asphaltic residue.

Track Elevation at Lynn, Mass.

By Charles B. Breed*

SYNOPSIS—Projects for the elimination of grade crossings of the Boston & Maine R.R., at Lynn, Mass., included both track elevation and track depression. The former was adopted, at first for two tracks and later for four tracks. A feature of the work was the crossing of a public square in the center of the city. The bridges are of steel, with concrete decks, and have the columns and exterior girders masked with concrete. A concrete-arch viaduct runs through the station grounds. Some open-deck bridges have been given a solid floor of plank and roofing paper. The history and development of the project as now carried out are described, as are also the methods of carrying on the construction.

The city of Lynn, Mass., 11 mi. north of Boston, has a population (1915) of about 100,000, and an assessed value of real and personal property of $90,000,000. The Boston & Maine R.R. line through Lynn before its elevation was from 5 to 20 ft. above mean high tide. It was proposed to abolish eight crossings on the main line and seven on the Saugus branch, both double-track roads, with respectively about 150 and 40 regular trains daily. All of the crossings on the Saugus branch were grade crossings. On the main line, those in West Lynn were grade crossings, while all of the crossings from Central Square to the east had already been provided with highway overpasses, except at Chatham St. The situation is shown by the plan and profile, Fig. 1.

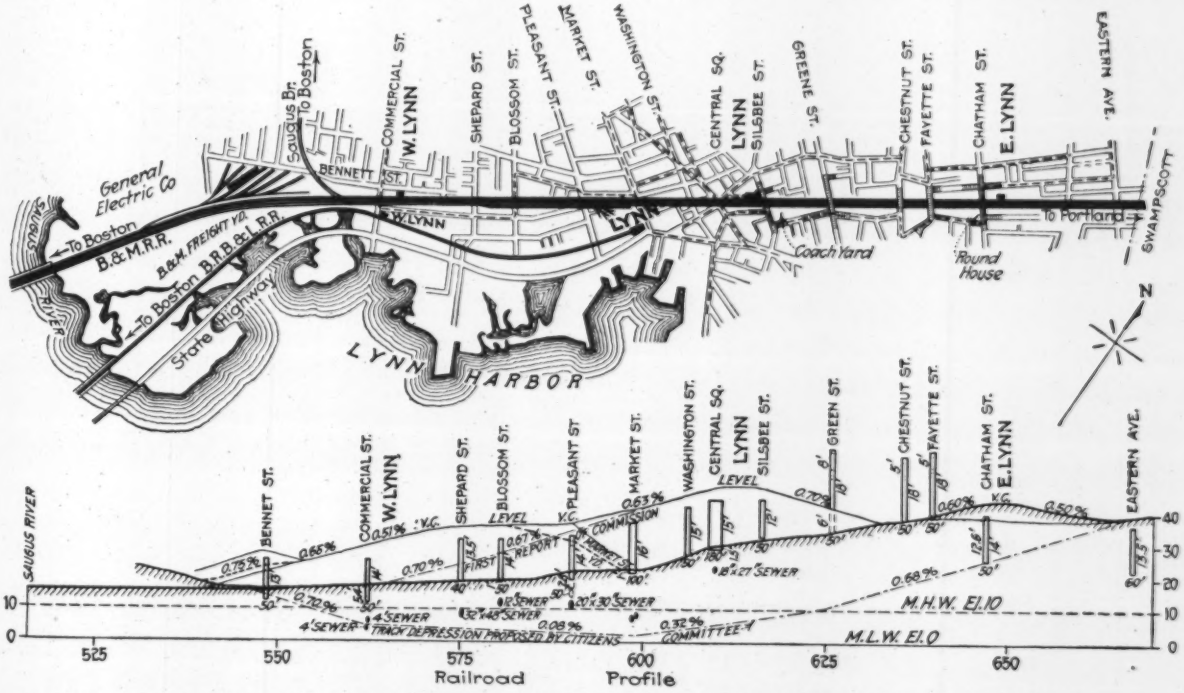


FIG. 1. PLAN AND PROFILE OF TRACK ELEVATION ON THE BOSTON & MAINE R.R. AT LYNN, MASS.

History of the Project

In July, 1901, the city engineer (the late George I. Leland) was instructed to prepare alternative plans for the abolition of grade crossings by depression and by elevation of tracks. His report showed that in 1901 at Central Square about 30,000 people and 2500 vehicles crossed the tracks daily, and that the gates were down about 3½ hr. between 6 a.m. and 11 p.m. At Washington St. about 7000 people passed, at Market St. 13,000, and at Pleasant St. about 5000. The gates were down at this last crossing for 7 hr. out of 17, and between 2 and 3 p.m. they were down 45 min. in the hour. In general this street was closed to traffic about half of the time, as it was located at the throat of the Market St. freight yard.

Five studies were made and estimated as follows: Main line elevation, $1,144,700; main line depression, $2,905,777; Saugus branch elevation, $418,320; Saugus branch depression, $635,875; Saugus branch relocation, $304,942. The city adopted the main line track-elevation plan. The railway also advocated track elevation; but its plan called for lower headroom and steeper approach grades on the streets, and for open-floor bridges throughout. Central Square is the industrial center of Lynn, the transfer point of all street-car lines, and contains the best business buildings. To have an open-floor railway viaduct 200 ft. long across Central Square was by no means desirable.

It was inadvisable to change the street grade to any extent at Central Square, on account of the value of the

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land and buildings. This resulted in an elevation of 18 ft. for the railway, bringing it to the grade of the Silsbee St. bridge over the tracks. The railway proposed to close this street and provide only a foot subway; but the city objected to this, as 14,000 people daily passed through Silsbee St. The city petitioned the Superior Court to appoint a special grade crossing commission, which made its report in 1906. It held that Silsbee St. should be closed, that public security and convenience did not require the immediate elimination of any crossings on the Saugus branch, and that two crossings on the main line could be left to a later time.

This report was opposed so strongly by the city that the Massachusetts Railroad Commission returned it for further consideration. The next report was made in 1909 and was the same as the first, except that it recommended the two extra crossings on the main line. In the meantime, however, the railway had agreed that a street in substitution for Silsbee St. should be built when necessity arose for it, the railway to pay 65% and the city

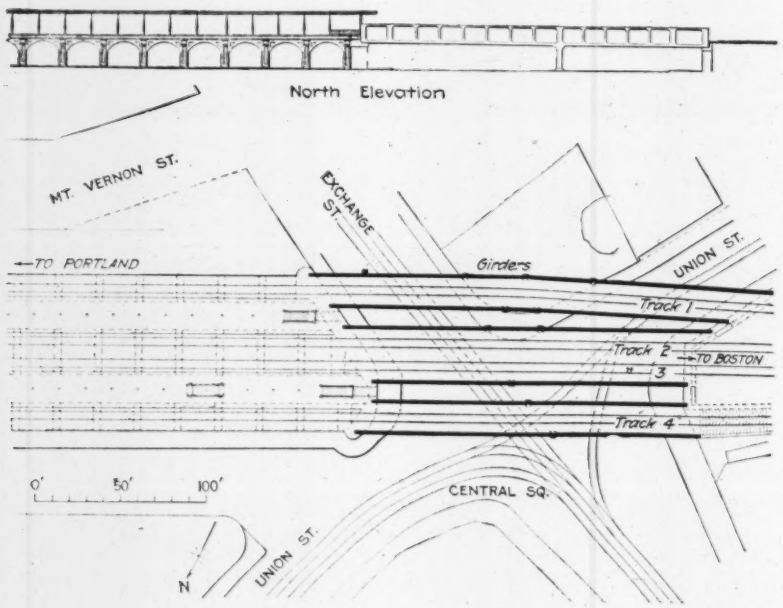

FIG. 2. CENTRAL SQUARE BRIDGE AND VIADUCT THROUGH STATION GROUNDS, LYNN, MASS.

35% of the cost. The Railroad Commission approved the report and the Superior Court made it a decree. Construction was started in September, 1909, at Commercial St. in the west end and at Chatham St. in the east end of the city.

About this time the New York, New Haven & Hartford R.R. obtained control of the Boston & Maine R.R. and proposed to four-track the line through Lynn, purchasing land for this purpose at a cost of nearly $1,000,000. To a committee of citizens Mr. Mellen, president of the railway, expressed himself in favor of track depression, were it not for the expense already incurred for track elevation. This was early in 1911. The municipal council then voted to assume the entire cost up to that date (about $624,000), and introduced a bill in the Legislature for a four-track depression project.

The railway company at that time estimated the cost at $4,495,000 for double-track depression and $1,412,000 for double-track elevation. The writer, representing the city, estimated the cost at $3,500,000 and $1,500,000 respectively. The railway alone was to pay the cost incidental to the two additional tracks.

The city's bill was not passed. The railway having purchased land for additional width of its location, as already noted, then proposed a bill modifying the two-track plans provided for by the court decree so as to allow for four tracks. The city took this opportunity to require that the construction, headroom, street approaches and bridges should be satisfactory to the city. The new act was drawn up jointly by representatives of the railway and of the city, and was passed by the Legislature in 1912.

This act provided, briefly, as follows: (1) A four-track elevation, with grade practically in accordance with the report of 1909; (2) Silsbee St. to have a subway the full width of street; (3) solid-floor bridges to be used, except at five streets where the bridges already had been fabricated or erected; (4) new highway bridges to be built at Green, Fayette and Chestnut St., with brick paving instead of plank floors, and to be maintained forever by the railway; (5) the bridges at Market, Washington, and Silsbee St., and Central Square, and the steel viaduct through the station grounds to have the girders and columns masked with concrete.

The Central Square bridge and the viaduct through the station grounds were required to be in accordance with a new plan which was presented with the act. This plan gave a minimum of columns in the square and a more attractive viaduct. It will be seen from Fig. 2 that the four tracks across Central Square are crossed by one double-track bridge flanked on each side by a single-track bridge, the lengths of span and positions of girders being accommodated to the street plan and street-railway track layout. Beyond this, a viaduct with arched spans extends to the station.

The act provided also that the railway should pay for all changes in overhead bridges and approaches east of the station, and that the cost of a two-track elevation should be divided among the railway, the city, the Commonwealth and the street railway company. All additional cost incidental to two extra tracks to be paid by the railway.

The Present Work and Its Cost

The work is now practically completed as a two-track elevation, but its expansion into a four-track line has not been fully accomplished owing to the financial condition of the railway. The total cost to date is about $3,000,000 (exclusive of the railway's additional right-of-way). About half of this is chargeable to the two-track system, and has been paid for as follows: The Boston & Maine R.R., 65%; the city, 10%; the Commonwealth, 17½%; and the Bay State St. Ry. Co., 7½%.

The expense to the railway, including its extra land for widening, will probably reach $3,500,000, which is a large outlay in view of the company's financial difficulties.

And unfortunately its benefits cannot be realized without additional expense. At Salem, 5 mi. east, is a single-track tunnel in the heart of the city. At Chelsea, between Lynn and Boston, the road has a double-track line with several dangerous grade crossings. It will cost about $6,000,000 to complete a four-track system from Boston to beyond Salem, where two important branches leave this division.

Fig. 1 shows a plan and profile of the work. The railway approached originally from Boston on the level and at 5 ft. above mean high water. From Commercial St. to Market St. it rose on a grade of 0.20%, and thence at 1% to Central Square. The latter grade was the maximum for the division and seriously affected freight traffic. It often caused very slow movements across the square, involving serious delays to street traffic (including fire-department delays). From the station eastward there was a rising grade of 0.32% for 2000 ft., followed by a level stretch. The other 1% grades can be eliminated at no great cost, and 0.7% is assumed as the maximum future grade for this division. The old alignment was followed.

The profile shows also the track-elevation project of the special grade-crossing commission (which was rejected) and the track-depression project of the city. The latter would have affected all the large sewers and lowered the railway nearly to low-tide level, requiring waterproof construction.

Methods of Construction

The general method of handling the work was as follows: At Chatham St. the two main-line tracks were first raised 6 ft. under traffic. Piles for two tracks were then driven and the tracks supported on the trestle. The street was closed to team traffic and the excavation was done by hand shoveling and teams. Many of the dwellings were so near the street line that they had to be shored, which was accomplished without settlement. When the two additional tracks were constructed in 1914, one on each side of the old double-track system, temporary trestles were first constructed across the street, and later replaced by permanent bridges. Typical views of the construction work within the city are shown in Fig. 3 with explanatory notes appended.

In the work at Commercial St., the tracks were first thrown far enough to the south to admit of constructing a two-track abutment. Then the street was excavated, and as this proceeded the tracks were also depressed to the grade of the new underpass, pedestrian traffic only being maintained on the streets. When the northerly half of the abutments was completed the traffic was turned onto the new elevation. A temporary runoff east of Commercial St. brought the elevated tracks to the old grade again at Shepard St. The next season the main-line tracks from Commercial St. to Market St. were thrown to the south far enough to permit the building of the retaining walls on the north side throughout this district.

These walls were partly constructed when work was held up on account of the introduction into the Legislature of an act which seemed destined to change the type of construction since it called for track depression. During this time the railway purchased a large amount of property between Commercial St. and Central Square, so that before work was resumed it was possible to demolish several buildings and to throw the tracks from West Lynn to Central Square still further to the south. This allowed not only the construction of the northerly wall but also the placing of filling adjacent to this wall sufficiently wide for two tracks.

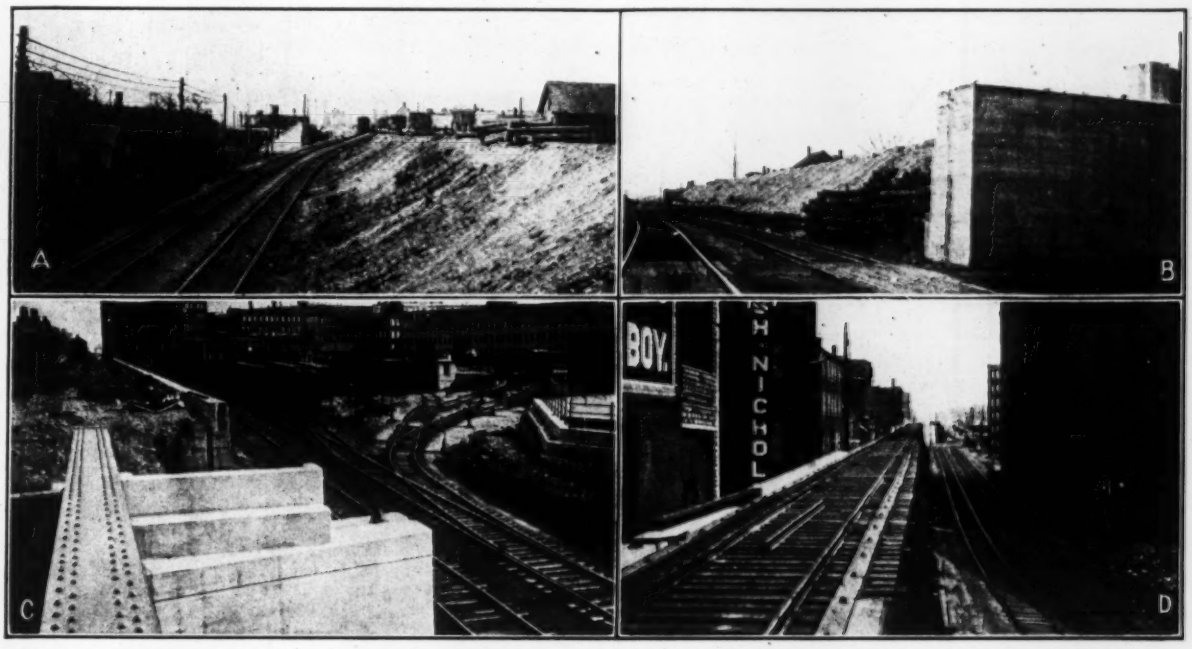

FIG. 3. TYPICAL VIEWS OF CONSTRUCTION WORK, BOSTON & MAINE R.R. TRACK ELEVATION AT LYNN

A—Looking west from Shepard St.; temporary low-level tracks at the left and elevation at the right. B—Looking west from Blossom St.; elevation completed for two high-level tracks. C—East from Pleasant St. bridge; two low-level tracks passing through the Market St. yard. The wall parallel with the track was part of the two-track elevation system (at the left) and was buried when this was widened to a four-track system. D—East from Market St.; two temporary low-level tracks and one track of the two-track elevated trestle. Top of retaining wall at the left.

The traffic tracks were moved south far enough between Market St. and Central Square to admit of constructing, not only the northerly wall, but also a two-track trestle (one track at a time) through this narrow district (Fig. 3). At Central Square the traffic tracks were thrown toward the south a considerable distance, which permitted the construction of a permanent viaduct

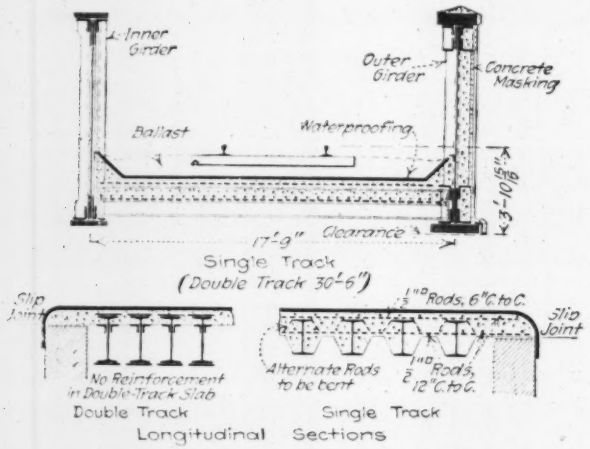

FIG. 4. SOLID FLOOR CONSTRUCTION; CENTRAL SQUARE BRIDGE SPANS

for three tracks from the Square through the station grounds to Silsbee St., and the runoff thence toward Green St.

By Aug. 9, 1913, all westbound traffic was carried on the elevated structure supported on permanent bridges or earth fill, except from Central Square to Market St. Then the trestle for east-bound traffic was constructed between Market St. and Central Square on the site of the old low-level temporary westbound track, and traffic was thrown onto the new elevated track. The temporary low-level tracks were then taken up, and the abutments at the various streets were extended to four-track width and the walls on the south side were constructed.

The widening out of the embankment was done from the eastbound traffic track. The fill between Market St. and Central Square was made from the trestle, principally at night and on Sundays on account of the large amount of regular traffic. The caps and stringers of the trestle only were reclaimed. The bridges on the main line were erected for two tracks before the traffic was turned onto the high level.

The runoff of the Saugus branch was raised entirely under traffic, both tracks being in operation during the construction. After the tracks had been raised to their full height, piling was driven at Bennett St., the excavation made and abutments constructed, while the railway traffic was carried on the two-track pile trestle.

Details of Bridges

All bridges were of the plate-girder type. The floor systems were field riveted. Seven of the spans in the Central Square bridge were 100 to 115 ft. in length; and the steel in this bridge weighed 1483 tons. Special derrick cars were used for handling these girders, the larger ones being placed at night.

Fig. 4 illustrates the type of floor for the solid-floor railway bridges. The concrete masking put on the outside girders is shown in Fig. 5. Much of this work was done during the winter time; steam coils were introduced into the forms, which were packed with straw to keep the concrete from freezing. The Central Square bridge floor had 674 cu.yd. of concrete and 1806 sq.yd. of waterproofing. The masking of the outer girders required 738 sq.yd. at the contract price of $4.25 per sq.yd. That on the Market St. bridge (Fig. 5) cost $935; Washington St. bridge, $493; and on the station viaduct and Silsbee St. bridge, $3638.

None of the bridges, except at Silsbee St. and Bennett St., had curb columns. In the former case they could not be avoided because the station platform extended across the street, so that the girders had to be shallow and therefore of short span. Bennett St. is in the outskirts of the city, near the new freight yard, and the city agreed to the cheaper construction in this place.

The remaining railway bridges were of open-floor construction, and under the act it was necessary to provide these with watertight decks. To meet this condition the railway constructed a watertight wood deck of special design on the steel flooring. The construction is shown in Fig. 6, but the floors have not been in use long enough to give conclusive evidence as to their success.

The ties are 7x10 in., 12 ft. long, with 4-in. oak blocks, carrying the track rails and guard rails. The open spaces are covered with two layers of tongued and grooved planking, secured by iron straps and screws. Between the two courses of planks are layers of felt, each mopped with coal-tar pitch. The openings at each side between the floor and the girders are closed by inclined sheathing in the plane of the gusset plates. This consists of two layers of ⅞-in. matched boards with a layer of roofing between them.

The highway bridges had steel floor-beams and wood stringers, carrying 4-in. hard-pine plank covered with

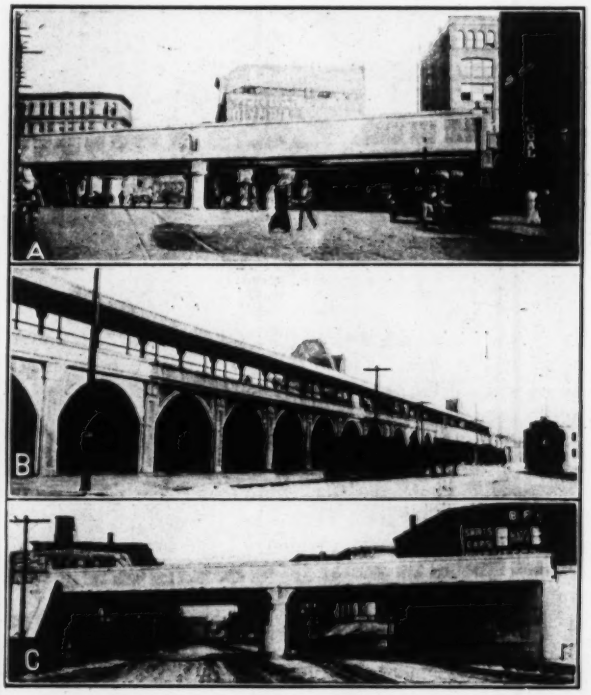

FIG. 5. TRACK ELEVATION STRUCTURES AT LYNN, MASS.

A—Steel bridge over Central Square. B—Concrete viaduct through station grounds. C—Steel bridge over Market St.

1½ in. of coal-tar pavement and waterproofing. On this was a 1-in. sand cushion for the brick pavement which was grouted with cement.

The bridges were constructed by the New England Bridge Co., Shoemaker Bridge Co., Boston Bridge Co., Phœnix Bridge Co., Pennsylvania Bridge Co. and American Bridge Co. The price for this steel work erected averaged 3.264c. per lb.

Concrete Work, Filling and Stations

The retaining walls and abutments were of gravity section, made with 1:3:6 concrete. No permanent piles were used on the project. The filling was principally sand and gravel, obtained from Peabody and Newburyport with hauls of 9 mi. and 27 mi. respectively. The gravel trains were equipped with air-operated dump cars, the spreading being done entirely by hand. There were practically no delays to regular train traffic throughout the entire period of construction.

The freight yards have been ballasted with gravel. The main-line tracks have stone ballast, hard-pine ties, Wolhaupter tie-plates, continuous rail joints and 85-lb. rails. There were only six private industry tracks leading from the main track. All of these were retained, some by building trestles on the owners' property and others by sidetracks on the railway right-of-way.

The filling was done by the railway company. The walls, abutments, station extension and viaduct arches were built and most of the street work was done under contract by T. Stuart & Son Co., of Newton, Mass. The Chatham St. project was carried through under a separate contract by the Farnum-Hanscom Co., of Boston. A few special contracts were let for remodeling the Lynn station and for special street pavement improvements. The unit prices paid T. Stuart & Son Co. on this work were as follows:

Excavation, earth, per cu.yd.	$0.50
Excavation, rock, per cu.yd.	2.50
Concrete masonry, plain 1:3:6, per cu.yd.	5.75
Concrete masonry, reinforced, per cu.yd.	7.25
Bar reinforcement in place, per lb.	.05
Waterproofing for arches (5-ply felt and 2-in. tar concrete), per sq.yd.	.85
Masking of bridges, per sq.yd.	4.25
Granolithic sidewalks, per sq.yd.	1.65
Furnishing and laying brick sidewalks, per sq.yd.	1.20
6-in. trap-rock macadam roadways, per sq.yd.	.60
Laying stone block paving, with sand joints, per sq.yd.	1.00
Grouting joints of stone block pavements, per sq.yd.	.20
Furnishing and laying first-class stone block pavement, per sq.yd.	2.85
6-in. concrete foundation for pavement, per sq.ft.	1.05
Manholes and catch basins, each	75.00
New curbstones in place, per lin.ft.	.90
Resetting curbstones, per lin.ft.	.20
6-in. sewer pipe furnished and laid, per lin.ft.	.90
8-in. sewer pipe furnished and laid, per lin.ft.	1.40
10-in. sewer pipe furnished and laid, per lin.ft.	1.60

The West Lynn and the East Lynn stations are small buildings built at the level of the elevated tracks and approached by stairs and inclined driveways. The Lynn station had originally two buildings, but the eastbound building was torn down and moved to another city. The westbound building was left at its original grade, and its main waiting-room was extended so as to pass under the elevated tracks, with stairway approaches to the island platforms. The extension of the waiting-room alone in this action cost about $51,000, whereas the total cost of station-building alterations, including new platforms, awnings, etc., was $106,000. This work was all done on a cost plus 10% basis, figured on the labor and materials, with no charge for plant or superintendence.

Parallel to and on the south side of the railway, between Central Square and Silsbee St., is Mt. Vernon St. (Fig. 2). This originally had an up grade of about 3½% from Central Square to the overpass at Silsbee St. The depression of Silsbee St. so as to pass under the railway introduced a hill with its summit midway along Mt. Vernon St. with a 3½% grade on each side. This hill was cut down, and a practically level street made, 50 ft. in width, which with the 20-ft. driveway in the station grounds resulted in a way 70 ft. wide. The city entered into a special contract with the railway in connection with this project, which included improved street pavements and some improvements in the station grounds. The city agree to pay 35% of the cost of that portion of the additional work which was done upon the street alone, including grade damages, and the railway agreed to pay the remaining 65%. The total additional cost of this project was $16,100.

Another special agreement was made between the railway and the city with respect to Bennett St. Originally this did not cross the Saugus branch, but the railway was raised to permit of extending the street. The railway agreed to pay for this additional raise and bridge construction, the city to pave Bennett St. from Commercial St. to the new freight yard.

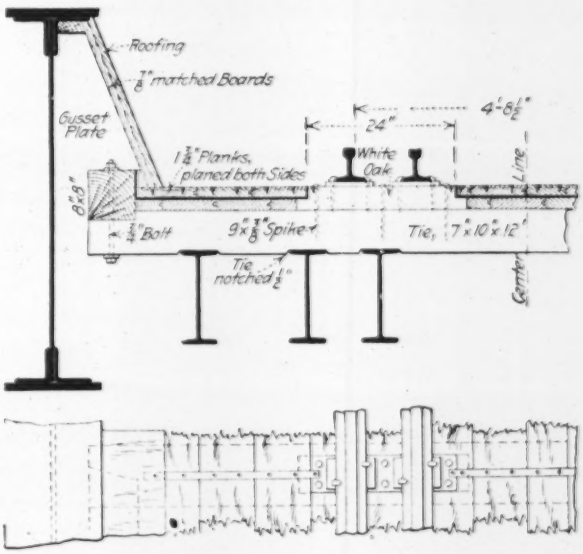

FIG. 6. WATER-TIGHT DECK FOR OLD OPEN-DECK BRIDGES IN LYNN, MASS.

Engineers

The work was done under three successive chief engineers of the Boston & Maine R.R.: H. Bissell, J. P. Snow and A. B. Corthell, the present Chief Engineer. The construction work was successively in charge of L. C. Lawton (now City Engineer of Haverhill, Mass.), F. C. Shepherd, Engineer of Construction of the Boston & Maine R.R., and G. L. Huckins, Division Engineer of Construction. The Resident Engineer for the railway was J. A. Parant. The bridges were designed by B. W. Guppy, Bridge Engineer of the Boston & Maine R.R. The Commonwealth was represented by H. W. Hayes, Chief Engineer of the Massachusetts Public-Service Commission. The Bay State Street Ry. was represented by David Curtin, Engineer of Maintenance of Way, and L. B. Reilly and F. B. Walker, Assistant Engineers. The municipality was represented by Wm. L. Vennard, City Engineer, and the writer, acting as consulting engineer.

Three Years' Growth of Street Traffic in Newark, N. J.

By Harland Bartholomew*

SYNOPSIS—Some interesting comparisons of traffic censuses made in 1912 and in 1915, showing the growth in vehicular traffic and the decreases in pedestrian and trolley traffic at Broad and Market St. accomplished by rerouting trolley cars.

Three years ago a traffic census was taken in Newark, N. J., chiefly with the end in view of effecting some relief to the traffic congestion at the corner of Broad and Market St., the city's main thoroughfares. A second similar census has just been completed, which offers many interesting comparisons and shows some of the relief effected. For an account of the 1912 census the reader is referred to the article by F. Van Z. Lane, in *Engineering News*, Sept. 12, 1912.

The police department has used and is using these censuses to regulate traffic and to determine points where traffic policemen are needed. The engineering department is using the figures in some instances as a basis for determining the type of pavement. The board of assessment and revision of taxes is using the data in making tax assessments. These uses of the traffic censuses are of course additional to those of the City Plan Commission, which made the counts with an aim to devising proper means for traffic distribution in the business section.

The completed count took approximately two weeks to accomplish with 30 special employees, although inclement weather conditions and torn-up pavements extended the time on a few counts one or two weeks longer. There were 107 places throughout the city where observations were taken for a period of 10 hr.—8 a.m. to 6 p.m. The observation points were upon thoroughfares where the greatest proportion of travel occurs. Counts were made always in the middle of the block to avoid confusion at street intersections and to observe accurately the total traffic passing through the street.

At each point note was made of the volume, character and direction of pedestrian and vehicular traffic. Vehicular traffic was classified according to character and weight, that is, whether the vehicle was drawn by one, two, three or four horses, with iron tires or rubber tires; whether it was a pleasure automobile or a small or large motor truck. Weights were determined according to whether the vehicle was empty, half full, or loaded.

*Secretary of the City Plan Commission, Newark, N. J.

Forms were provided for the enumerators so that all of these data were easily recorded. The field notes were tabulated upon daily sheets by the amounts of traffic in 15-min. intervals, so that it is possible to tell specifically the character and amount of traffic at any or all points during any period of the day.

Observations were not made on Saturdays, Sundays, holidays or on rainy days, thus avoiding abnormal conditions. The counts were also made at the same time of year as those of 1912 for equitable comparison.

An attempt was made to count for an entire week at one point in order to determine the daily traffic variation. Owing to extremely inclement weather conditions which prevailed last spring this was impossible. However, counts were made on seven different clear days at one point, and the results obtained are shown in Table I.

It will be noticed in this count that no great difference occurs in traffic on the different days, a maximum difference of 30% being noted in pedestrian travel on Monday and Tuesday. The counts for Saturday and Sunday do not compare favorably with those of the other days of the week. Monday is the heaviest day of the week in pedestrian travel.

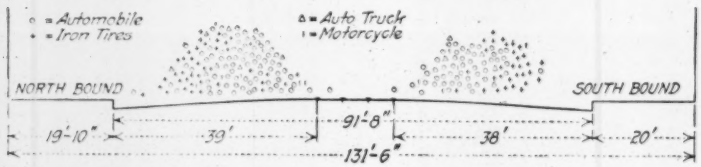

FIG. 1. TRAFFIC FOR ONE HOUR ON BROAD ST., NEWARK, N. J., BETWEEN COURT AND FRANKLIN ST.

Showing approximate distribution of traffic on the cross-section of the street—a new wood-block pavement

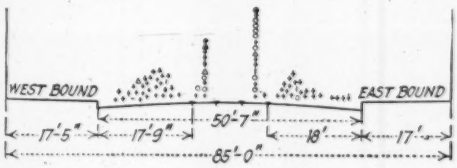

FIG. 2. TRAFFIC FOR ONE HOUR ON SPRINGFIELD AVE., NEWARK, N. J.

Showing distribution over cross-section with old granite blocks in poor condition

TABLE I. VARIATION IN DAILY TRAFFIC

			Roadway Traffic		Sidewalk Traffic		
Day	Date	Time Hr.	Number Vehicles, Total	Total Wt. of Vehicles, Tons	West Side	East Side	Total Pedestrians
Sunday	4-18-15	10	1529	2614.50	872	562	1434
Monday	4-19-15	10	2402	4724.00	1241	571	1812
Tuesday	4-27-15	10	2402	4970.00	868	529	1397
Wednesday	4- 7-15	10	2061	4110.75	1164	598	1762
Thursday	4-29-15	10	2462	4036.25	1085	559	1644
Friday	4-30-15	10	1951	4053.75	1009	443	1452
Saturday	5- 1-15	10	2550	5031.75	810	569	1379

A chart was made showing the totals of each kind of traffic at the several observation points for 1912 and 1915, also the total increase or decrease and percentages of increase or decrease. While pedestrian traffic throughout the city increased 9.16 per cent., vehicular travel increased 23.84 per cent. These figures are an indication of increased activity despite the present business depression. According to the recent state census the population increased only slightly over 3 per cent. during this period.

Observation points showing an increase or decrease in excess of 30% in either vehicular or pedestrian traffic were plotted on a map to indicate their comparative locations. Of these, there were five points where pedestrian traffic decreased and 49 points where it increased. There were four points where vehicular traffic decreased and 35 points where it increased.

The points of excessive decrease in pedestrian traffic are explained by the rerouting of the trolley cars and interruptions to traffic because of construction work. The points of excessive decrease in vehicular traffic are all explained by increases on parallel thoroughfares because of new pavements or because of construction work. The many points of excessive increase in pedestrian traffic are the result both of rerouting trolley cars and of the normal increase of population. The points of excessive increase in vehicular travel are in consequence of new and better pavements and of the large total increase in vehicular traffic.

Table 2 shows the comparative counts of traffic at the intersection of Broad and Market St. in 1912 and 1915.

TABLE 2. TRAFFIC AT BROAD AND MARKET ST., 1912 AND 1915

Between	Vehicles		Cars		Pedestrians	
	1912	1915	1912	1915	1912	1915
Market St. (E.) Beaver and Broad St.	2,277	3,636	1,955	1,697	68,253	41,550
Market St. (W.) Halsey and Broad St.	2,252	3,261	1,517	1,664	77,036	72,556
Broad St. (S.) Mechanic and Market St.	4,052	6,052	1,097	1,245	52,109	53,547
Broad St. (N.) Bank and Market St.	4,210	5,974	1,535	1,255	82,493	72,071
Total	12,791	18,923	6,104	5,861	279,891	246,724
Percentage of increase or decrease		+47.99%		−3.98%		−11.85%

These results are doubly interesting since this is the busiest point in Newark and reputed to be one of the busiest corners in the country. The decrease in pedestrian traffic resulted from the recent rerouting of the trolley cars, while the increase in vehicular traffic was caused by the new wood-block pavement on Broad St. as well as by the normal increase of the city. The recent rerouting of the trolley cars was designed especially to relieve congestion at this intersection.

The actual decrease in pedestrian traffic at this point is not to be deprecated, since this corner long ago reached the saturation point, and the rerouting of the trolley cars has helped to spread the surplus traffic. Vehicular traffic at this point will undoubtedly continue to increase until other channels are provided for it.

The increases in all kinds of traffic verify the previous assertions of the City Plan Commission that the growth of the city is taking place chiefly to the south and west.

A comparative analysis of the total vehicular traffic in 1912 and 1915 is shown in Table 3, which also shows the actual number of each type of vehicle counted and the percentage of increase or decrease.

TABLE 3. TOTAL VEHICULAR TRAFFIC; 1912 AND 1915

	Iron Tires	Motor Trucks	Automobiles	Rubber Tires	Street Cars	Total
1915	69,471	15,322	72,463	7,342	43,483	208,081
1912	79,823	5,065	34,016	10,338	38,755	167,997
Inc. or dec.	−10,352	+10,257	−38,447	−2,996	+4,728	+40,084
Percentage	12.97%	202.51%	113.03%	28.98%	12.20%	23.840%

While the decrease in the number of horse-drawn iron-tired vehicles is at first rather surprising, it will be noticed that the increase in the number of motor trucks corresponds closely to this decrease, which is an indication that business is really on the increase, since a motor truck carries considerably more than the horse-drawn vehicle. The average weight of motor-truck traffic is 3.66 tons per vehicle as against 2.22 tons per vehicle of the horse-drawn type. Table 4 gives the total number and weights of motor trucks and iron-tired vehicles.

TABLE 4. COMMERCIAL VEHICLES AND WEIGHTS; 1912 AND 1915

	Iron Tires	Weights	Auto Trucks	Weights
1912	79,823	183,273.75	5,065	22,752.00
1915	69,471	154,428.75	15,322	56,128.25
Inc. or dec.	−10,352	−28,845.00	+10,257	+33,366.25
Percentage	12.97%	18.68%	202.51%	146.59%

Table 5 shows that a larger number of small motor trucks are evidently being used than formerly, since the average weight is decreasing.

TABLE 5. AVERAGE WEIGHT PER VEHICLE

	1912	1915	Difference
Iron tires	2.28 tons	2.22 tons	0.06 tons
Motor trucks	4.49 tons	3.66 tons	0.83 tons

The decrease in horse-drawn rubber-tire traffic, which is usually of the pleasure-vehicle type, is greatly offset by the enormous increase—113%—in automobile traffic, which includes runabouts, touring cars and limousines only. The count was completed before the advent of the so-called "jitney bus," some 200 of these having subsequently appeared in the city.

The increase in street-car traffic is a clear indication of added service (12%), which corresponds favorably with the total increase in pedestrian travel (9%).

The proportions of different kinds of vehicular traffic in the city in 1912 and 1915 is shown in Table 6.

TABLE 6. CHARACTER OF VEHICULAR TRAVEL; 1912 AND 1915

	1912		1915	
	Total	Per Cent.	Total	Per Cent.
Iron-tire	79,823	47.5	69,471	33.4
Motor trucks	5,065	3.0	15,322	7.4
Automobiles	34,016	20.2	72,463	34.8
Rubber tires	10,338	6.1	7,342	3.5
Street cars	38,755	23.2	43,483	20.9
	167,997	100.0	208,081	100.0

Innumerable conclusions could be drawn from a study of the figures at hand. A statement of general conditions and conclusions concisely stated follows:

Vehicular traffic in the city increased 23.84%.

Pedestrian traffic in the city increased 9.16%.

Trolley traffic in the city increased 12.20%.

Horse-drawn traffic, which decreased 12.97%, is being supplanted by motor trucks, which increased 202.51%.

Automobile traffic increased 113.03%.

Rerouting of trolley cars decreased pedestrian traffic at Broad and Market Sts. 11.85 per cent., while there were corresponding increases on Broad St. and Park Place in the vicinity of Central Ave., also at Market and Mulberry Sts. New pavement on Broad St. caused an increase of slightly over 50% in vehicular traffic on that thoroughfare.

Figs. 1 and 2 illustrate the approximate position taken by vehicles in two wide thoroughfares, one with a good pavement and one with a poor pavement. The designations indicate the center of the vehicle. Standing vehicles it will be noticed are responsible for lack of travel close to curbs. The illustrations are a clear indication of where the wear of pavement is to be expected.

E. P. Goodrich, of New York City, is consulting engineer of the commission; under his general supervision, the traffic work was in charge of A. B. Cozzens, assistant engineer, and the writer.

Material Rejected Under Test by the Pennsylvania R.R. System is reported for certain classes in a recent bulletin. The following table gives the acceptances and rejections in one year in six of the more important classes:

	Quantity Tested	Quantity Rejected
Steel castings (pounds)	77,700,000	500,000
Steel wheels (number)	128,000	4,000
Axles (number)	165,000	8,000
Bar iron (pounds)	150,000,000	6,000,000
Air brake hoses (number)	635,000	85,000
Cotton waste (pounds)	3,800,000	400,000

The total value of supplies, materials and purchased equipment tested and inspected in a representative year exceeds $80,000,000, and the cost of making these tests is a little more than one-half of 1% of that value.

Dominguez Central-Station Irrigation System

By Chester B. Loomis*

The irrigation system of the Dominguez Water Co. in southern California is an interesting example of central pumping-station development. The Dominguez Rancho, one of the old Spanish grants, about 14 mi. south of Los Angeles, contains approximately 20,000 acres of highly productive land. One part (*A* on accompanying map) was irrigated by individual electric motor- or gas engine-driven centrifugal pumps with a lift of not more than 25 ft. Another part (*B*) was partly irrigated by vertical gas-engine centrifugal pumps with a lift of from 75 to 125 ft. to the surface. Under some land (*C*) there are no water-bearing gravels at a depth that would allow of economical irrigation.

Considering the low lift and the long pipe lines necessary, it was found more economical to continue irrigation on the "*A*" lands as before and to install a system for the "*B*" and "*C*" lands only. During the preliminary work 4000 acres were sold for the industrial city of Torrance.[1] A stipulation was made that water should be supplied to the city by the Dominguez pumping station. No changes in the plans, beyond the design of the piping system, were required, as it is a well-known fact that when an agricultural district becomes a residential and manufacturing district, in general the same amount of water (say one miner's inch to 7½ acres) is required.

Wells and Canal

The water supply is taken entirely from wells and raised to the surface by air lifts. Steam-pumping engines serve the irrigation lines. Six wells (see map) lie east

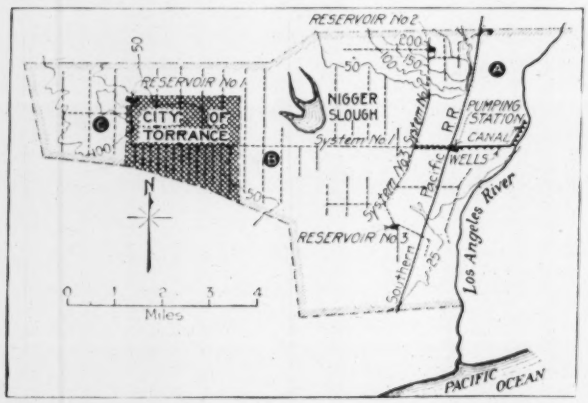

FIG. 1. IRRIGATION LINES ON DOMINGUEZ RANCHO

of the pumping-station site and a second line of six wells was drilled in a northerly direction along the bed of the Los Angeles river. The six wells on the east and west line from the station are shallow, being approximately 100 ft. deep with the water level standing from 10 to 40 ft. below the surface, depending on the season and pumpage. These wells were drilled 500 ft. apart, so that the cones of depression during pumping would not intersect except in case of excessive draft. The deep wells along the river bed average about 500 ft. in depth and flow approximately 200 gal. per min. each; but during pumping the level is lowered to approximately 30 ft. below surface. When pumping is stopped for about 36 hr. they again commence to flow. These six wells are also placed 500 ft. apart. All wells are 12 inches in diameter, cased with double No. 12 gage, red-iron stovepipe casing and were drilled with a standard California rig. The shallow-well casings, being in fine gravel and coarse sand, were given six rows of very narrow perforations equally spaced around the circumference. The deep-well casings are in coarse gravel and were given six rows of cuts ¼ in. wide. Each well was thoroughly sand pumped.

Over each well is a concrete box 3 ft. square by 5 ft. high (inside), the well casing projecting 18 in. above the concrete floor. From these boxes short pieces of 10-inch riveted steel pipe deliver the water into a concrete-lined canal, which extends from the farthest well to the pumping station sump. This canal has a fall of 2 ft. per mi. and increases in capacity from 10 sec.-ft. at the farthest well to 35 sec.-ft. at the pumping station.

This canal discharges through screens into a 250,000-gal. concrete sump, which acts both as a settling basin and a regulator for the pump supply. The sump is connected to the pumping station by a large concrete-lined tunnel.

Pumping Station

The pumping station is a reinforced-concrete structure 110 ft. long by 50 ft. wide and 23 ft. high to the bottom chord of the roof trusses. As there is no snow load and the roof has a pitch of 5 to 1, the trusses are of extremely light steel on 10 ft. centers. The roof is of galvanized corrugated iron. The exterior walls are paneled and finished in splatter-dash, making the building very attractive.

A right-angle extension of the sump tunnel, 4x6 ft. in section, runs along the wall nearest the sump. Short chambers open from it for the suction pipes of Pumps 1 and 2. This avoids blocking the tunnel with large suction pipes and keeps it out from under the pump foundations. All suction lines in the station, including those of the auxiliaries, take their water from this tunnel.

Boilers

There was no attempt at separate engine and boiler rooms, since with crude-oil fuel there is no dust or dirt. The boilers are installed across one end of the engine room. This leads to better attention, as they are always under the eye of the operating engineer. It also does away with the fireman, for the oiler can easily handle the fires in addition to his regular duties. The load is practically constant, and often the fires do not need attention for several hours at a time.

There are two water-tube boilers (standard Stirling type for 150-lb. working pressure) set in a single battery, with room for a single third boiler. This space is temporarily occupied by the machine shop. The settings are raised 1 ft. higher than standard to increase the volume of the combustion chamber.

The boilers are fired with crude oil under 40- to 50-lb. burner pressure. Each boiler has two front-fired burners (Wilgus type), set just inside the fire doors and throwing a fish-tail flame horizontally toward the bridge wall.

At first one boiler had two center-fired burners, designed by the writer, set in the center of the brick-covered grates. After careful tests the efficiency of the two types was found practically the same, except under very heavy

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[1]Described in "Engineering News," Oct. 30, 1913.

overloads, when the center burners showed up about 1½ per cent. better. The stack-gas analyses showed from 13.5 to 14 per cent. CO_2 under normal running conditions for long periods. As the plant load is practically uniform, the front-fired type was used on both boilers because of easier removal for repair and cleaning.

Fuel oil is delivered at the plant in tank cars; the tracks being high enough for gravity unloading. A permanent 7⅝-in. line is laid underground from the railroad to the station tank, which is of reinforced concrete, 25 ft. in diameter by 10 ft. deep. All that is necessary to unload a car is to screw a large funnel into the delivery line, spot the car discharge over the funnel and open the valve. The station fuel pumps take their supply directly from the storage tank. In case the oil in the station tank is too cold to be handled by the fuel-oil pumps, it may be heated around the pump suction pipes by steam coils.

Air Compressors and Pumping Engines

Two single-stage air compressors (14- and 27x19x24-in. cross-compound condensing) supply the well air lifts. Cooling water for the condensers is drawn from the suction tunnel and discharged into the sump outside. The compressors have mechanically operated inlet and automatic exhaust valves, automatic lubrication, pressure governors, safety stops, reheating receivers, etc. The air inlet pipes lead vertically upward through the roof.

There are three pumping engines, each being normally operated under a different head; but the designs allow two pumps to serve each one of the three irrigation systems, thus preventing water shortage due to the breakdown of any unit.

Pump 1 is a 16- and 34x16x36-in. cross-compound condensing Corliss-type crank-and-flywheel high-duty engine, with outside center-packed water ends. It is equipped with a combined speed and pressure governor, suction condenser, direct-connected suction valveless air pump, automatic lubrication, etc. This pump normally operates against a head of 139 ft., but is capable of delivering water into Line 2 against a head of 250 ft.

Pump 2 is similar to Pump 1, except in the water end, though this is also outside center packed. This pump is 16- and 34x12x36-in. and operates normally against a 250-ft. head.

Pump 3 consists of an impulse steam turbine driving two 8-in. centrifugals through reduction gearing (all De Laval machines). These pumps work against a 60-ft. head at 1500 r.p.m. The turbine exhausts into a jet condenser which takes cooling water from the suction tunnel and discharges back into it. By this scheme a long and complicated condenser discharge pipe is avoided, and by proper position of the condenser discharge lines the water in the tunnel is not raised perceptibly in temperature.

Auxiliaries

The auxiliaries consist of two 7x4½x10-in. boiler-feed pumps, a 500-hp. open feed-water heater, a fuel-oil pumping set (comprising two 4x3x4-in. duplex pumps mounted on a stand together with an oil heater and pressure regulator), a 10-kw. 110-volt direct-current generator, direct connected to a vertical high-speed engine taking steam either from the main boilers or from a 15-hp. vertical-boiler outfit which is complete with feed pump and injector. The little boiler can be fired either with wood or oil and is used particularly to furnish steam for atomizing the fuel oil when starting up the main boilers and to operate the 10-kw. generator when the main boilers are shut down and night work is to be done.

The machine shop contains an 18-in. swing lathe and a 48-in. drill press, driven by a gasoline engine. When the third boiler is installed the machine shop will be removed to the building now occupied by the blacksmith shop and storeroom; but it is at present more convenient to have the shop where the engineer can attend to the work while the plant is in operation.

Irrigation Lines

Irrigation Line 1 is served by Pump 1 and consists of a 33-in. riveted steel force main approximately 8 mi. long discharging into a 20,000,000-gal. reservoir. The reservoirs on all three lines are in earth and are lined with crude oil well worked into the dirt. This makes a very satisfactory and completely water-tight lining. From the force main laterals are run out at right angles every 2000 ft., so as to cover all the lands served by this particular line. These laterals vary in size according to the hydraulic head, so that each one has the same discharge. The outlets on this line and also on Line 2 all have standard 4-in. iron-body brass-mounted gate valves.

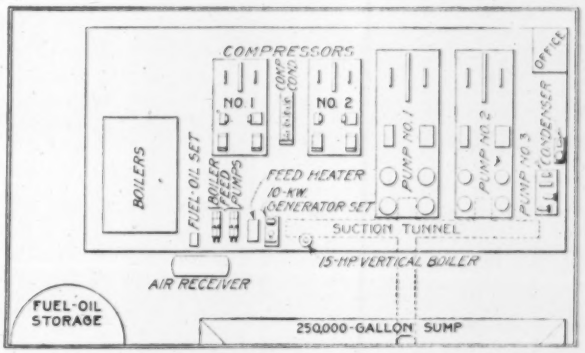


FIG. 2. LAYOUT OF DOMINGUEZ PUMPING STATION

Line 2 is served by Pump 2 and consists of a 20-in. riveted steel force main delivering into a 7,500,000-gal. reservoir. Owing to the topography of the land served by this line it was not possible to run laterals from the force main, so trunks were run from the reservoir and laterals from these trunks. Line 3 is served by Pump 3 and consists of a 20-in. riveted steel line delivering into a 7,500,000-gal. reservoir. Laterals are run from the force main and from trunk lines out of the reservoir. On account of the elevation of certain portions of the land served by this line the reservoir is so piped that it may be bypassed and the irrigation water pumped directly on the land.

All water consumers on the various systems purchase their water through meters, these meters being checked by Venturi meters at the pumping station.

This plant was designed and installed by the writer and has been in operation now for two years. It has proved very efficient and reliable.

Inexpensive Electric Service for unwired dwellings is being promoted by the Louisville (Ky.) Gas & Electric Co., by offering a low-priced panel board for service in one room. A steel panel carries a meter and a two-socket receptacle. A 12-ft. cord and a 60-watt tungsten lamp is included in each outfit. A light and a fan or a flatiron, or any two current-drawing devices, can be used at one time. The rest of the house may be wired starting with this panel as a base, and it is expected that many installations will grow in this way.

A Generalized Form of Hooke's Law

By E. R. Hedrick*

It has been known for a long time that many materials fail to satisfy Hooke's law exactly, even within the range usually described as below the elastic limit. Even such substances as steel and wood have measurable variations from this law that have long been recognized by physicists and engineers.[1] Other substances, such as cast iron, concrete, bronze, copper, stone, rope and so on, depart from the law very widely indeed.

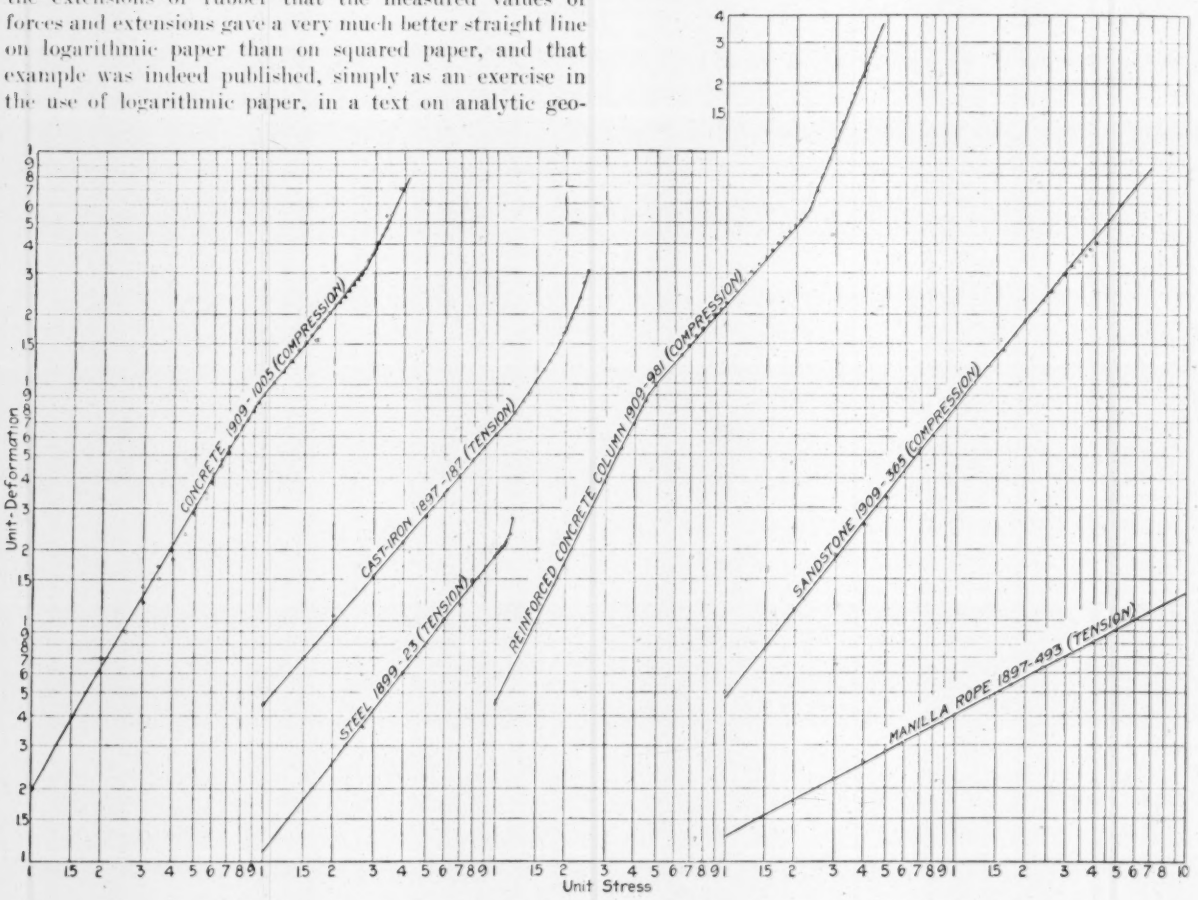
The writer discovered originally for a set of data on the extensions of rubber that the measured values of forces and extensions gave a very much better straight line on logarithmic paper than on squared paper, and that example was indeed published, simply as an exercise in the use of logarithmic paper, in a text on analytic geometry with which the writer was connected.[2] This means, of course, that the relation between the force p and the extension e is in that example much better expressed by a relation of the form

$$p = ke^n \quad \text{or} \quad e = cp^{\frac{1}{n}} \qquad (1)$$

if n is taken *different from unity*. In the example just mentioned the value of n was found to be approximately 0.625.

It seemed less likely that other substances would show any similar behavior; but it at least suggested itself that a comparison would be illuminating, if for no other purpose than to bring out the contrast between rubber and other substances. For this purpose I have been working over the data contained in the Reports of the Watertown Arsenal, in which the numerical results of the actual tests of a large number of substances are given. Contrary to my original expectation, I soon began to suspect that the effect noticed in the example mentioned is not peculiar to rubber, but occurs also with many other substances.

I have now worked over a substantial part of the tests in several of the volumes of the Watertown Reports, and I think it is safe to announce that these results follow a straight line on logarithmic paper[3] better than they follow a straight line on squared paper, in a very large number of cases.


Unit-Deformation
Unit Stress
CONCRETE 1909 - 1005 (COMPRESSION)
CAST-IRON 1897 - 197 (TENSION)
STEEL 1899 - 23 (TENSION)
REINFORCED CONCRETE COLUMN 1909 - 981 (COMPRESSION)
SANDSTONE 1909 - 365 (COMPRESSION)
MANILLA ROPE 1897 - 493 (TENSION)

LOGARITHMIC PLOTTINGS OF SOME STRENGTH TESTS OF VARIOUS MATERIALS
References are to "Tests of Metals," Watertown Reports

For steel, of which the tests are most numerous, the value of n is quite close to unity, but it is in most instances very definitely different from unity, and there are specimens[4] that give values as low as 0.69. The majority of specimens of steel give values of n over 0.85, but many specimens give values less than 0.9.[5]

Some other substances give values of n near to unity. Thus, an excellent specimen of long-leaf yellow pine, under compression, follows a straight line on logarithmic paper with remarkable fidelity, and gives a value not far from

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[1]See, e.g., Thurston, "Materials of Construction," pp. 346-347; U. S. Board, 1881, pp. 217-221; Poynting and Thompson, "Properties of Materials," p. 53; etc.

[2]Ziwet and Hopkins, "Analytic Geometry," p. 275.

[3]The proper initial extension for the initial load must be determined by trial of several logarithmic plottings.

[4]"Watertown Arsenal Reports," 1897, p. 317.

[5]Watertown, 1899, pp. 23 to 47 and p. 163.

0.95.[6] Other specimens of wood show greater divergence; thus, a piece of fir, across the grain,[7] gave $n = 0.85$, approximately.

Other substances show still great divergences. Thus, a specimen of cast steel (Watertown Reports, 1899, p. 351) gives $n = 0.74$. Two specimens of cast iron (1910, pp. 161-2) give 0.69. Several specimens of copper (1907, pp. 78-81) give a set of remarkably parallel lines that correspond to 0.56. A specimen of sandstone (1907, p. 365) gives 0.80.

A case that is worthy of mention is that of rope. A piece of manila rope (1897, p. 493) gives a very good line for $n = 1.94$. Confirmatory evidence that this case is not accidental is to be found in the same volume.

The behavior of concrete, both plain and reinforced, is very remarkable. Evidently, a further study of this important substance is desirable, as will be seen if an attempt is made to draw the corresponding lines. Throughout long ranges of values the pressures and compressions follow a straight line on logarithmic paper. These lines take suddenly a different direction, as will be seen in a most pronounced fashion if even a hasty sketch is made of the test in Watertown Report 1909, pp. 981-982, in the range from 1000 lb. to 4400 lb. per sq.in.,

An interesting confirmation is afforded by the tests on the strength of iron girders conducted by the United States Board and reported in detail on pages 217-259 (Report, 1881). The variation from theory noticed by the board (pp. 217-220), which appears prominently in the numerical data and in the large graph inserted near page 281, seems to check with what would be expected from the theory proposed in the present paper. The numerical data plot as straight lines on logarithmic paper up to the elastic limit in the case of every beam measured by the board. The elastic limit itself shows very strongly on the logarithmic graphs, and it would appear from certain remarks appended to the report that uncertainty remained in the minds of the board in several instances which are perfectly determinate on the logarithmic graphs. The formulas for the deflection d produced by a center-load w are

$$d = Kw^n \quad \text{or} \quad w = Cd^{\frac{1}{n}} \qquad (2)$$

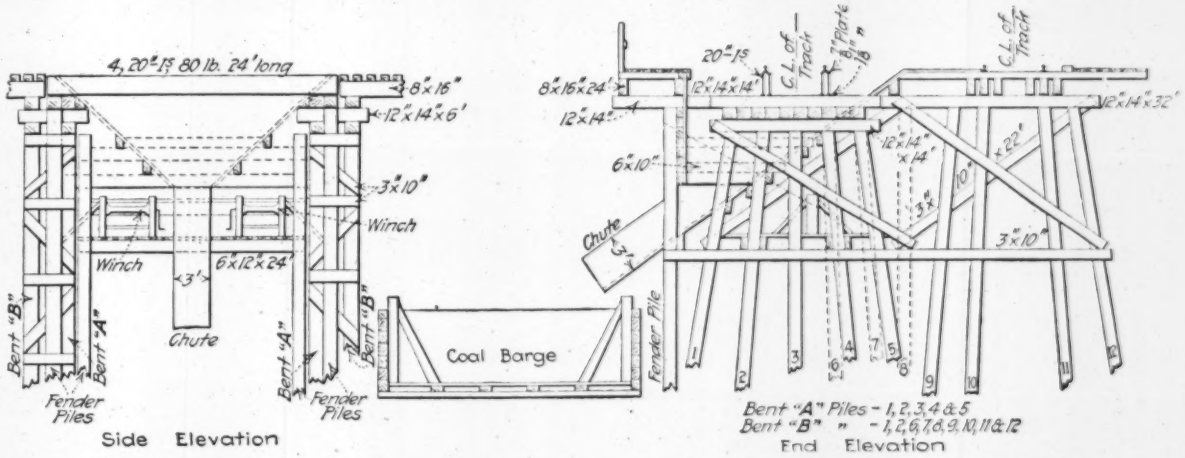
where n varies from a trifle less than 1 to a minimum of 0.74 (see page 240) for this set of tests. It will be remarked that this range of values is practically the same as that found for direct-tension experiments. These formulas agree with beam formulas which I have deduced on assuming that eq. (1) holds for direct tension and compression.

[6] Watertown, 1897, p. 420.
[7] Watertown, 1896, p. 386.

River Terminal at East St. Louis

The Alton & Southern Ry. is a new 15-mi. belt line which serves a large portion of the industrial district at East St. Louis, Ill. It connects with nearly all the railways entering this district and has a water terminal (known as the Fox Terminal) on the Mississippi River just south of the city, near Carondelet. This was mentioned in an article on "Port Improvements Along the Mississippi River" in *Engineering News*, June 3, 1915.

The terminal has a double-track timber trestle 1400 ft. long, with an average height of 20 ft. above the water. This can accommodate barges on both sides. Lumber and heavy freight are handled between barges and cars by a 50-ton locomotive crane, having a hoisting capacity of 20 tons. Package freight is delivered from pier to barge by spiral chutes, and is handled from the barges by the crane, the freight being placed in slings.



FREIGHT PIER AND COAL HOPPER OF THE ALTON & SOUTHERN RY., AT EAST ST. LOUIS, ILL.

Special facilities are provided for shipping coal, and it is expected that a large traffic in Illinois coal will be handled in this way. The coal is delivered at the pier in railway dump cars and discharged into a track hopper, from which a hinged spout delivers it into the barge. At high water, when there is not enough fall for this gravity chute, the coal is carried from the hopper by a conveyor on a boom. During the first month's operation about 3000 tons of coal and 10,000 tons of bauxite were shipped from this pier.

The terminal has about 3400 ft. of track, with accommodation for 10 cars on the pier and storage room for 50 cars, so that freight can be handled promptly. The facilities provided are in excess of present needs, and are so arranged as to allow for enlargement with the expected increase in the water-borne freight traffic. The cost was about $50,000. E. S. Fickes is Chief Engineer of the Alton & Southern Ry., and for information and plans we are indebted to him and to W. N. Aubuchon, Jr., manager of the East St. Louis Association of Commerce.

5000-Hp. Chain Drive for a Hydro-Electric Plant

The Ox-Bow hydro-electric plant on the Snake River, in Oregon, has the distinction of possessing the most powerful chain-drive gear in the world. This feature was not intended in the original design, but was introduced to adapt existing machinery to modified conditions and plans. The plant is owned by the Idaho-Oregon Light & Power Co., and is located about 50 miles north of Huntington, Ore. It has been in operation for some months.

The location is at the downstream end of a sharp bend or loop in the river. The original project provided for a tunnel across the neck of land, the tunnel being about 1160 ft. long and 26 ft. diameter. The floor was 10 ft.

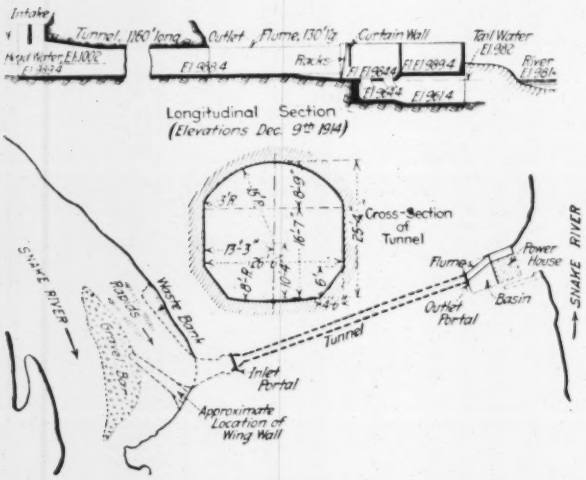


FIG. 1. PLAN AND LONGITUDINAL SECTION OF THE OX-BOW HYDRO-ELECTRIC PLANT ON THE SNAKE RIVER, OREGON

below low water at the intake end, and had a fall of 1:1000. This gave a natural head of from 20 to 22 ft., depending on the stage of the river, and was little affected by flood- or low-water conditions. This is shown in Fig. 1. In addition, a diversion dam was to be constructed about 1000 ft. below the tunnel intake, raising the headwater level 30 ft., and thus affording about 50 to 52 ft. head.

The power plant, at the lower end of the tunnel, was designed for the installation of six units, each consisting of two pair of 48-in. waterwheels operating in open flume through center-discharge shaft tubes and direct-connected by flange couplings to a 3600-kw. alternating-current three-phase 60-cycle generator running at 225 r.p.m. The plant was also to contain two 250-kw. direct-connected exciters operated by independent waterwheel units.

Financial difficulties necessitated the stopping of construction when the tunnel had been finished, except for the openings from the headgates in the river. The power-plant foundations had been completed to the floor level in two units and to the spring line of the arches which were to support the floor in the remainder of the plant. Machinery had been purchased and the waterwheel apparatus delivered for three units, as was also the structural steel for the entire power plant. The dam to give the intended head had not been built. This condition continued for several years until the appointment of a receiver in December, 1913.

The receiver and the bondholders of the company employed Prof. John R. Allen, of Ann Arbor, Mich., and W. H. Rosecrans, consulting engineer, of Chicago, to examine the condition of the property and suggest some means of developing power.

With the low head available (20 ft. instead of 50 ft.), and the consequent reduction in power, the turbines could not be run at the speed required for the generators. But as the machinery had been delivered it was desirable to utilize it rather than order new equipment. Direct connection being out of the question, some form of gear transmission was considered, and the engineers recommended the installation of a single unit composed of two waterwheels and one generator, with a chain-drive transmission. This plan made it possible, with comparatively slight changes, to use the machinery already purchased. The expense was much lower than by another system of development, and only a small proportion of this expense would be lost if the plant should be altered later in accordance with the original plans.

The arrangement of the connections of this generating unit to provide for the necessary difference in speed of the waterwheels and generator is shown in Fig. 2. The waterwheels are placed parallel instead of in line, and the generator is slightly above them. Shaft extensions were introduced to carry the chain drive.

Each of the two waterwheel shafts carries a 71-tooth sprocket wheel 45.49 in. diameter, while the generator shaft carries two corresponding 47-tooth sprockets, 30.31 in diameter. Each pair of sprockets carries four Morse silent driving chains 31.67 ft. long and 21 in. wide, weighing about 2800 lb. each. The pitch is 2 in. throughout. The sprockets are made in halves and bolted on the shafts, which are 129 in. c. to c. The speeds are 149 r.p.m. for the waterwheel shafts and 225 r.p.m. for the generator shaft.

The chains have been tested to a strain of 40,000 lb. per sq.in., but the maximum tensile strain under ordinary

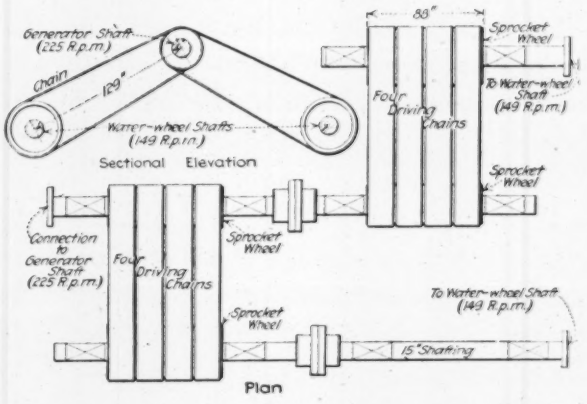


FIG. 2. 5000-HP. CHAIN DRIVE FROM TWO WATER-WHEEL SHAFTS TO A SINGLE GENERATOR SHAFT: OX-BOW HYDRO-ELECTRIC PLANT

operating conditions will be 600 lb. per sq.in. It is stated that the largest chain drive previous to this was of 1500 hp., so that this 5000-hp. drive is by far the largest yet installed.

The designs were made in the office of the W. H. Rosecrans Engineering Co., of Chicago, and the installation was made under the direct supervision of Mr. Rosecrans.

John R. Allen, Professor of Mechanical Engineering at the University of Michigan, acted as consulting mechanical engineer.

The New Sewerage System of Cairo, Egypt

The ancient city of Cairo, Egypt, is situated on the delta of the Nile. Its site is so nearly level that it was difficult to lay out a system of sewerage for the city in the ordinary way, with gravity discharge. In laying out the new sewerage system for the city which has been recently put in operation, therefore, the city has been divided into small areas and the sewage from each of these areas, after flowing by gravity to a central sump is forced by compressed air through closed pipes leading to a main outfall sewer.

So far as we are aware, this is the most extensive installation of compressed air apparatus for the forcing of sewage from district collecting stations that has ever been made. It is of course not novel as the Shone compressed-air ejector for forcing sewage has long been used in England.

A brief description of the Cairo system was given by Dr. E. L. Corthell in a paper published in "Professional Memoirs," Corps of Engineers, for May-June, 1915, following his visit to Cairo while the works were under construction. From this and from additional information furnished to Mr. Corthell recently by C. Carkeet James, M. Inst. C. E., under whose direction the works were constructed, the following description has been prepared.

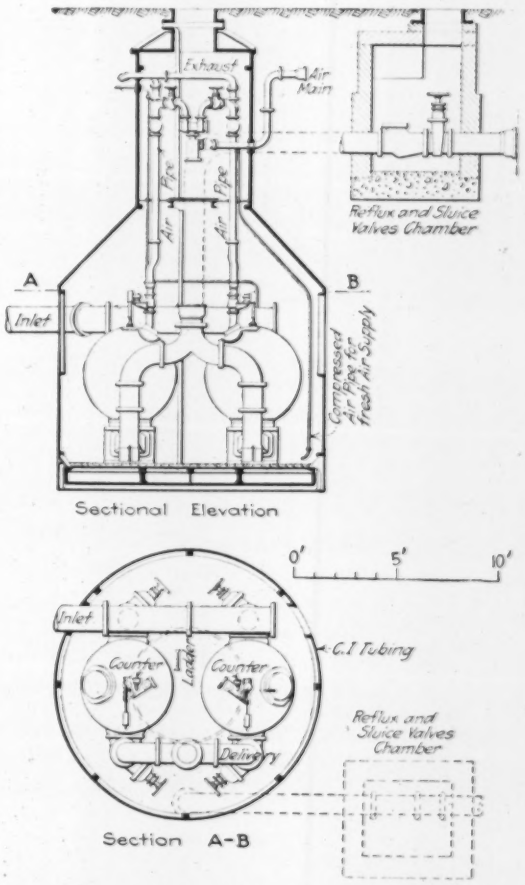
The total area in Cairo to be drained with the aid of compressed air is a strip 3 to 4 km. broad extending along the Nile for nearly 12 km. This tract has been divided into 63 small areas. In each of these the sewage flows by gravity to an underground compressed-air discharging station. From each of the stations the sewage is forced by compressed air through closed cast-iron pipes into a gravity outfall conduit, 1.6 m. in diameter, which starts at Pont Ghamra.

The accompanying drawing shows a section of a compressed-air discharging station. Each station contains two spherical cast-iron sewage receivers. The sewage from the district draining to the station flows into the receiver by gravity until the receiver is filled. A float in the receiver then opens a valve admitting compressed air and at the same time closes another valve, which shuts off the inflow of sewage. The compressed air forces the sewage contained in the receiver out through a discharge pipe leading from the bottom of the receiver. When the receiver is empty the compressed air is cut off and the inlet valve is again opened. The process is entirely automatic, and the apparatus is claimed to have been so designed as to require little supervision to keep it in working order.

The compressed air used to operate the sewage-discharging stations is furnished by a central station, where there are four air compressors driven by triple-expansion engines delivering air at a pressure of from 22 to 25 lb. per sq.in. To insure continuous service, the compressed-air mains from the central compressing station to the sewage-discharging stations are laid on the loop plan.

In the main outfall sewer the sewage flows by gravity to a pumping station at Kafr-el-Gamus, a distance of 13½ km., receiving the discharge from various suburban gravity sewerage systems on the way. At the pumping station the sewage is screened and then forced by plunger pumping engines through a cast-iron delivery main, 0.92 m. diameter, to a sewage farm at Gebel-el-Asfar, a further distance of 11½ km.

The sewage farm (on which the sewage will be used for irrigation) is a tract in the desert about 4 km. square. The sewage delivered from the force main will pass through sedimentation tanks, and a portion of it may be further purified on gravel filter beds. It is expected that about 3000 feddans of land (3300 acres) will eventually be irrigated by sewage. About 350 feddans have been graded to receive irrigation water, and 170 feddans have been planted with 35,000 fruit trees, while 80 feddans of cereals are under cultivation. About 80 km. of compressed-air mains and sewage force mains from the compressed-air stations have been laid. Only a small part of the gravity sewers discharging to the compressed-air stations, however, has as yet been constructed. The area around the principal hotels and that near the military barracks, as well as some of the important suburbs, have been sewered. Further work on the laying of sewers was interrupted by the outbreak of war. The expenditure on the works thus far completed under Mr. James' direction is about £1,500,000 Egyptian. Approximately £500,000 Egyptian more will be required for laying the small sewers to the compressed-air discharge stations. The system has been planned for the needs of a population of about 1,000,000.

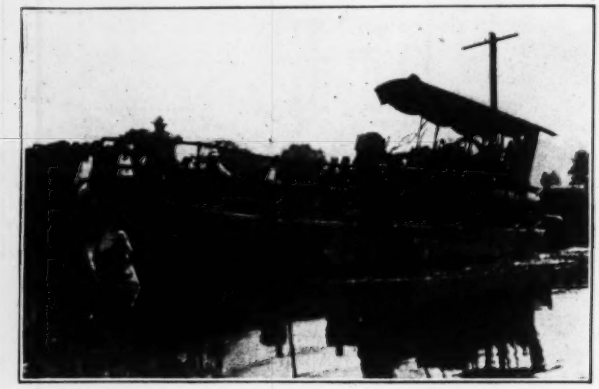


SECTIONAL VIEWS OF COMPRESSED-AIR DISCHARGE STATION, CAIRO SEWERAGE SYSTEM

Flood Wrecks Masonry Bridges*

In a heavy rain on July 28 in the northern part of Chautauqua County, New York, a number of bridges and culverts were washed out. Particular interest attaches to the failure of three masonry bridges of different types.

The Mason bridge at Dewittville on State Road No. 5263A was a 24-ft. span consisting of a 20-in. slab of gravel concrete, reinforced with 7/8-in. bars spaced 4 5/8 in. c. to c. and 1/2-in. bars spaced 12 in. c. to c. across the road. It was built in 1912. Failure was due to undermining of both abutments, the water washing out the bed of the stream from a normal depth of about 18 in. to a depth of 12 ft. The roller seen standing on the bridge in the view belonged to the Ontario Roads Co., contractors for the state road at this place. It happened to be standing on the bridge at the time for the purpose of blocking the road, which was closed on account of other construction work. The high-water mark was about 18 in.



REINFORCED-CONCRETE SLAB BRIDGE WRECKED BY ABUTMENT UNDERMINING

over the roadway. The flood carried away about 600 cu.yd. of earthwork and the total damage is estimated at $2500.

The second bridge to fail was the Lefingwell bridge, an 8-ft. stone-arch culvert under the Buffalo-Erie highway. This was a structure of long standing. Practically all of the culvert was carried away, only a small length of the barrel remaining. How this stood up while the earth and masonry from above were carried through it is hard to explain. About 1000 cu.yd. of earth was taken away with the bridge. The total damage is estimated at about $2000.

The southeast wing wall of the Glenn Mill bridge, a 30-ft.-span concrete arch near Westfield was overturned, allowing the stream to carry away about 1500 cu.yd. of earth from the uncompleted fill. This failure was illustrated in *Engineering News*, Aug. 19, 1915, p. 379. The wing was previously cracked and the high water softened the toe of the slope, allowing the earth back of the wall to push it over. High-water marks indicated that the water reached a depth of about 10 ft. above normal. During the dry season of the previous year, while the bridge was under construction, all the water was carried through a 12-in. pipe. The damage is estimated at $2500.

In accordance with New York State Highway Law bridges of over 5-ft. span are town charges whether located on state and county highways or not, and steps have already been taken by the town officials for the replacement or repair of all these bridges.

*Information furnished by W. M. Acheson, Division Engineer, New York State Commission of Highways, Buffalo, N. Y.

State Supervision of Public Water-Supplies in Kansas

By Fred R. Hesser*

An effective plan for state supervision of water-supplies has been used for the past two years by the Kansas State Board of Health. Some of its details may be of interest to others connected with public-health work.

The water and sewage law passed in 1907 provides for the appointment of an engineer for the State Board of Health from the faculty of the Engineering School of the State University. The head of the Sanitary Engineering Department has always held this appointment as head of the Water and Sewage Division of the State Board of Health. The work of this division has increased in volume till at the present time two assistant engineers and a stenographer-clerk are employed. A laboratory is also maintained by this division at the University. It employs a force consisting of the director, chemist, bacteriologist, three laboratory assistants and two stenographers.

The provisions of the water and sewage law are as follows:

> That no person, company, corporation, institution or municipality shall supply water for domestic purposes to the public within the state from or by means of any water-works without a written permit from the State Board of Health for the supplying of such water. The application for such permit shall be accompanied by a certified copy of the maps, plans and specifications for the construction of such water-works or extension, and of a description of the source from which it is proposed to derive the supply and of the manner of storage, purification or treatment proposed for the supply previous to its delivery to consumers, together with such other data and information as may be required by the State Board of Health; and no other or additional source of supply shall subsequently be used, nor any change in the method of treatment be made without an additional permit. The supplying of water without a permit shall be deemed a misdemeanor, punishable by a fine of not less than $25 nor more than $50 for each offense. Each day shall constitute a separate offense.

The board is empowered to make any investigations of water-supplies upon complaint of municipal or public-health officers or to act upon its own motion, and to order such changes in the source of supply or method of treatment as may be necessary to safeguard the public health. Permission to discharge sewage into streams or other bodies of water must also be obtained from the board under practically the same conditions as to treatment as those described. The engineer and secretary of the board are empowered to act when the board is not in session.

The consulting engineers practicing in the state have come to realize that the provisions of this law do not work a hardship upon them but, on the contrary, serve to maintain a standard under which competition is more nearly fair and open. Consequently they are, with few exceptions, glad to coöperate with the engineers for the board in their requirements. Upon being advised that a town or corporation contemplates the construction of a water-works or a change in an old system, one of our engineers visits the town and makes a thorough inspec-

*Assistant Engineer, Kansas State Board of Health, Lawrence, Kan.

tion of the plant and discusses conditions with those in charge and with the engineers for the work.

The plans and information, when completed, are sent to the office of this division at Lawrence and must include the following items: General plans, detail plans, engineer's report, specifications, application. These are examined not only from the viewpoint of quality of supply but also that of adequacy for future growth, fire protection and mechanical efficiency. If necessary they are returned with a request that corrections be made and when satisfactory the blueprints are stamped "Approved" and signed by the engineer for the board. One copy of the plans is filed in the office of the secretary at the State House in Topeka and another in the engineer's office at the University. Arrangements have just been made to furnish blank progress-report cards to engineers in charge of such work. These will be returned to the office each month.

There are 197 plants in the state supplying water to municipalities. Of these, 16 are privately owned, 27 use surface water and rapid sand filters and 14 use surface water with no further treatment than coagulation and sedimentation.

Analyses of samples from each supply have been made at frequent intervals during the past three years, the surface water-supplies being watched very carefully. When sufficient evidence of poor quality of any water has been collected the city authorities or owners of the plant are approached and the improvement can usually be brought about without recourse to a formal order from the board. Occasionally, however, it has been necessary for the board to order improvements recommended by its engineer. Within the past year seven modern rapid sand filter plants have been installed by this method, and work is in progress on four more.

Acceptance of purification plants by the city or owner is made contingent upon approval by the State Board of Health. When ready for operation an engineer from this division, usually accompanied by the laboratory director, takes charge of the plant and operates it for two or more days. Alkalinity and turbidity determinations are made on the raw, coagulated, and filtered water at frequent intervals and bacteriological samples are plated on agar at hourly intervals. Bacteriological samples are also collected at two- or four-hour intervals and expressed to the laboratory in refrigerating shipping containers for check counts and B. coli fermentations. The test also includes calibration of orifice boxes, rate regulators and loss-of-head gages, quantity of wash water used and rate of application of wash water and air, clarifying effect obtained in the basins by the use of varying chemical doses applied at various points. The bacteriological standard heretofore required has been "a removal of 98% when the raw water count exceeds 3500 per c.c. or a count of less than 100 per c.c. in filtered water when the raw-water count is less than 3500 c.c., with complete removal of turbidity." The operators of these plants are instructed in making alkalinity titrations with erythrosene and turbidity readings with a candle turbidimeter. Compact kits containing the required apparatus and reagents are furnished at cost by the laboratory. The operators are also furnished a pad of blank-form operating reports. A duplicate copy of each is sent to the engineer's office each month. Since these plants are rarely large enough to employ a chemist this method enables us to check their operation. Usually the plant purchases a shipping container and weekly bacterial examinations of their samples are made free.

The refrigerating containers are manufactured in Lawrence for the laboratory of this division.[1] They consist of an insulated outer case and tightly fitting top from which is hung a copper box with divisions for 4 or 6 bacteriological sample bottles. Cracked ice is placed in the bottom and low temperature held for 48 hours.

Rules recently adopted by the Board provide for annual inspections of all water-works and sewage-disposal plants in the state by the engineers of this division. Standard information blanks will be used for recording the results of these inspections. Mineral, sanitary chemical, and bacteriological examinations of all ground water-supplies will be made twice each year and surface water-supplies will be examined bacteriologically, chemically, and microscopically each week. Each plant is charged a fee, graduated, according to the population supplied, from $12.50 to $150 per year. These fees are used to maintain the laboratory.

Sources from which common carriers supply drinking water are to be inspected and sampled twice a year. Springs, wells and other sources from which water is bottled and sold for domestic or public use will also be under the direct supervision of the State Board of Health.

Sulphur Causes Garbage-Reduction Odors

Study of the cause and prevention of odors and dust from garbage-reduction works in New York City has been made by the Central Testing Laboratory of the City of New York and a detailed report is given in the *Journal of Industrial and Engineering Chemistry* of the American Chemical Society, September, 1915. At the plant studied the garbage arrives at the docks in open scows and is conveyed to large lined iron tanks or digesters. These are vented and the gases have considerable odor. The cooked garbage and liquor are run into vented receiving tanks before being pressed. Liquids are run to open settling tanks where the grease is skimmed off and the liquor discarded. The pressed garbage goes to direct-heat driers which give off odor and dust perceptible for miles around. The dried garbage is conveyed to a naphtha-extraction plant, and the tankage is dried in a second set of direct-heat driers with more odor and dust.

The odors from handling raw garbage, from the grease-separating tanks, from pressing and from conveying garbage under treatment are of only local importance. None of the substances (principally mineral matter and fats) carried over mechanically with the digester vent gases were found important. The condensable volatiles included essential oils and sulphur compounds. The extremely nauseating odor of uncondensable vent gases was found due largely to sulphur compounds. Simple heating of vent gases was useless, but washing with a solution of calcium hypochlorite prevented odors.

The scrubber installed removed 91% of the total dust from drier gases and 70% of the odorous substances. Leading the gas across pine-tar oil substituted the odor of the latter for the objectionable smell. No reasonable amount of a dilution with air was effective.

[1] See illustrated description, "Engineering News," Oct. 23, 1913, p. 819.—Editor.

Engineering Literature

Faults of Technical Literature

By R. Fleming*

Technical literature may be divided into two classes: That which finds its way to the public through periodicals, and that which appears in book form. This article has in mind the latter class, though much of what is written will apply to both divisions.

A glance through the catalogs of publishers of technical books will show what a bewildering number has been written on certain subjects. New books on Applied Mechanics are continually being brought out. Three books on Foundations closely followed each other in 1914. Books on Structural Engineering are being multiplied. Are all these books needed? A university lecturer in an article[1] entitled "Books for Engineers—A Criticism," in the Engineering Supplement of the London *Times*, of Jan. 31, 1912, writes thus of a search he had made:

> Two or three impressions were gained by this search. One was that a flood of technical books is emanating from America. . . . To come to the faults of the technical books which are now appearing so rapidly, many of them are badly written, badly arranged and badly priced. . . . Many authors do not appear to have in mind any definite purpose for their books. They do not seem to take the trouble to ascertain if such a book is really needed. They do not ascertain before beginning their task how far the field is really covered.

Books describing industrial processes are hardly out of the hands of the printer before the processes have been modified and new books are needed. But about those on Mechanics dealing with unchanging principles it is well to ask whether the new are better than the old. Of course, the best book on any subject is yet to be written. Not every writer has the confidence expressed in the preface of a textbook on Applied Mechanics: "The author claims that the chapters on Moment of Inertia, Center of Gravity, Work and Energy, Friction and Impact are more complete in theory and application than those of any other American textbook."

Most technical books are written by teachers in technical schools and colleges. There are several reasons for this. The teacher has access to libraries, is able or should be able to express himself clearly, and from his teaching experience knows the difficulties in grasping new subjects. Moreover, he has time at his disposal to which the professional man is a stranger. The college year seldom lasts over forty weeks and recitations and lectures are confined to comparatively few hours per week. Knowing that he may be rated according to the number of books he has written, he embodies his notes and lectures in a book, thus adding another to a field that may be well covered. The responsibility for overproduction rests largely upon the boards of trustees of our various institutions of learning, who in choosing a faculty generally put more stress upon authorship than upon teaching ability.

One cause of lack of accuracy is the acceptance without discrimination of what has already been written. An erroneous statement once fairly started has a surprising tenacity of life. Hutton's formula for wind pressure on inclined surfaces, although discredited, is constantly met with in textbooks, and handbooks. The Carnegie "Pocket Companion," edition of 1913, gives it, the Cambria Steel Co.'s Handbook, 1914, quotes it without a name attached, and the Handbook of the Lackawanna Steel Co., 1915, quotes it as Unwin's formula. Dates are often given wrongly, especially in footnotes. Euler's column formula is found dated both 1757 and 1759. In this case there is an explanation. The paper "Sur la Force des Colonnes, Par M. Euler" appeared in the "Histoire de l'Academie Royale" for the year 1757 but the volume bears the imprint, Berlin, 1759.

First editions are often lessened in value because of the number of errors resulting either from careless preparation of the manuscript or careless proofreading. One book before the writer has twenty-seven errors in twenty-two consecutive pages. Some are trifling but others are serious. A student has the help of his instructor in detecting errors, the "constant reader" will probably find them from the context, but the busy man who regards his library as his dictionary is liable to be led astray. The engineer who passes a problem with a given book to an assistant may receive an absurd answer or none.

From a large number of errors which have caused annoyance, three will be cited from books of recognized merit:

1. The "American Civil Engineers' Pocket Book," second edition, page 297, gives as the formula for bending moment of a cantilever beam uniformly loaded, $M = \frac{Wx^2}{2}\left(\frac{3}{4} - \frac{x}{l}\right)$. This should be $\frac{Wlx}{2}\left(\frac{3}{4} - \frac{x}{l}\right)$.

2. Johnson, Bryan and Turneaure in their analytical treatment of wind loading in "Modern Framed Structures," eighth edition, page 512, write: "and substitute the values of M and S_2 in (11b)." In this edition equation (11b) is not given and it is necessary to consult earlier editions.

3. Ketchum in "Steel Mill Buildings," third edition, page 119, in the figure of a double portal, gives a stress of 4242 lb. in the member c — 7 and the same in member c — 8. In each case it should be 2121 lb. The stress diagram is correctly drawn but the reader does not stop to scale a diagram. He looks at the stresses given on the figure. From this figure he would infer that for a double portal the stresses in certain members are equal to the stresses in certain other members when they are but one-half as much.

Lack of clearness occurs when an author leaves too much to be understood by the reader. In one standard treatise on Mechanics the reader must at times determine from his previous knowledge of the subject the meaning of + and —. A single sentence would clarify the whole matter. Another book that has passed through several editions contains an article of five pages on "The Flexure of Long

*American Bridge Co., 30 Church St., New York City.

[1]Reprinted in part in "Engineering News," of April 18, 1912.

Columns." Near the close of the section is a paragraph commencing: "Euler's formula, therefore, is strictly applicable only to . . . ". While the student may infer that the formula deduced is the well-known Euler formula, it is not so expressed and the paragraph does scant justice to Euler.

Flexure in beams is almost invariably treated without any mention that the beam is considered as stayed laterally. One textbook, "Stresses in Structures," in showing how to use the tables in the rolling-mill handbooks quotes the full tabular load as the strength of a 9-in. beam with span of 20 ft. No mention is made of the proviso so explicitly stated in the handbook that the tabular loads apply only to beams stayed sideways. A note like the following, used in another book, would have left no room for doubt: "Due attention in selecting the beam must be given to lateral and vertical deflection as previously noted, or to a proper reduction of the specified fiber stress to allow for these reductions." In this connection it is noted that reports of beam tests lose their value when they do not state how the beam is stayed sideways.

It is conducive to clearness to find in all the pages of a book the same symbol denoting the same thing. Greene's "Structural Mechanics" is an illustration. In the introduction the author says: "The notation is practically uniform throughout the book and is that used by several standard authors." It is also a great help to find an introductory page or an appendix tabulating in alphabetical order all the symbols used. A few books give this. May their number be increased! A step farther would be a more general agreement among authors to use the same notation.

Plagiarism is an ugly word to use and happily the fault is not common. Yet occasionally when two books are compared it may be inferred that one copied from the other or that both borrowed from a common source. Some again quote a great deal and give credit for little. More prevalent still is the use of the work of thinkers and scholars without any mention of their names. Goodman's "Mechanics Applied to Engineering" is a model in the giving of credit. Instances are: Young's Modulus of Elasticity, Bow's Notation, Barlow's Theory, "the method is due to Professor Dalby," "the author and Mr. R. H. Thorpe of New York." Molitor is also to be commended. In the preface of his "Kinetic Theory of Engineering Structures" he states: "Each subject is prefaced by a few brief historical remarks and all important theorems bear the name of their originators, a practice which has been shamefully neglected by many modern writers." This is quite in contrast to the practice of some others to whom the lines of Kipling might apply:

When 'Omer smote 'is bloomin' lyre,
He'd 'eard men sing by land an' sea;
An' what he thought 'e might require,
'E went an' took—the same as me!

The market-girls an' fishermen,
The shepherds an' the sailors, too,
They 'eard old songs turn up again,
But kep' it quiet—same as you!

They knew 'e stole; 'e knew they knowed.
They didn't tell, nor make a fuss,
But winked at 'Omer down the road,
An' 'e winked back—the same as us!

In closing let it be said that despite its faults technical literature was never better than it is today.

Transition or Spiral Curves

REVIEWED BY HENRY J. SAUNDERS*

THE RAILROAD TAPER: The Theory and Application of a Compound Transition Curve Based upon Thirty-Foot Chords—By Lee Perkins, Formerly Assistant Engineer Southern Pacific Lines in Arizona and Mexico. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Flexible leather; 4x7 in.; pp. x + 356; 41 text illustrations; 42 tables. $2.50, net.

In the "Railroad Taper," Mr. Perkins has presented the subject of transition or spiral curves as developed by William Hood, chief engineer of the Southern Pacific Co. The curve used is a series of compound curves developed from a basic chord length of 30 ft. A set of tables is also given based on the 10-meter chord for use in Mexico and South America.

Mr. Perkins' work as a whole, although it cannot be said to be the last word in spiral curves, still seems to be such an improvement over other books and tables on the subject that it deserves little criticism and much praise. The writer has taken the trouble to compare this work with some ten or more others on the same subject and can say that with one or two exceptions this is the only work which can be used easily and universally by the man in the field under nearly all conditions.

The writer believes that a better understood title for the book should have been selected or at least that the word "curve" should have immediately followed the word "taper." Of some ten books examined no one of them used the word taper, three using "spiral," four "transition curve," two "transition spiral" and one "parabolic curve." Webster defines the noun "taper" as "a gradual diminution of thickness in an elongated object," referring more to volume than to surface.

The writer believes that Mr. Hood had some well-defined reason for the selection of the 30-ft. basic chord length and believes that should be brought out in this work, owing to the fact that a great many engineers look with disfavor on any unit of measurement which will not go into 100 an even number of times.

The location and track problems selected are good and cover the usual run of problems encountered in the field. The tables are ample, although the writer believes that a more definite nomenclature should be selected for the different types of taper in order that the necessary table could be selected at a glance without having to study out the system of numbering.

The author explains fully the relation of the speed of the train to the length and number of the taper selected. This is a point which cannot be too fully impressed upon the field engineer.

The slight changes which have been suggested would make the book of general value to engineers, although as it stands it can certainly be used as well or better than any other work on this subject.

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A summary of the operating results of the water-softening and filtration plant of McKeesport, Penn., occupies a large part of the annual report for 1914 of the water and lighting commissioners of that city. A folding table giving data by months and by yearly averages for six years is included. There is also a description of the plant. The summary was written by Edward C. Trax, chemical engineer, who is in charge of the filtration plant.

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The Theory of Direct-Acting Steam Pumps

REVIEWED BY H. E. LONGWELL*

DIRECT-ACTING STEAM PUMPS—By Frank F. Nickel, Associate in Mechanical Engineering, Columbia University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. x + 258; 218 illustrations. $3, net.

The author has set himself a rather thankless task, for the reason that his subject is one that has ceased to be of much general interest from an engineering standpoint. He has developed a somewhat elaborate theoretical treatment of the direct-acting steam pump, which it is hardly probable ever existed in the minds of the pioneer designers of this type of machine, whose lead apparently has been blindly followed by their successors.

Table 17 (page 181), giving a list of standard sizes of boiler feed pumps, furnishes sufficiently convincing evidence that to a large extent designs for this type of pumps have been based on "rule-of-thumb" methods rather than on exact calculations. If the design were based on logical principles it is evident that the ratio of diameter of water cylinder to steam cylinder should be fairly uniform throughout the list. If, as the author states, the mechanical efficiency increases materially with the length of the stroke, it is obvious that any departure from uniformity should be in the line of an increasing ratio in the larger sizes.

If a 4-in. water cylinder is correct for a 6-in. steam cylinder with 6-in. stroke and 65 per cent. mechanical efficiency, there can hardly be any good reason for making a water cylinder so small as 5¼ in. in connection with a 9-in. steam cylinder of a 10-in. stroke pump, having an alleged mechanical efficiency of 75 per cent., or a water cylinder only 7 in. diameter for a 12-in. steam cylinder of a 12-in. stroke pump of 77.5 per cent. mechanical efficiency.

Inasmuch as substantially the same list has been "standard" for over thirty years, it is apparent that the matter of proportions of water cylinder to steam cylinder has never been given any serious engineering consideration. Furthermore, there is no evidence that the proportions of any of the so-called "standard" sizes are really logical.

The book opens with a short chapter on the development of the direct-acting steam pump. This is followed by a chapter on performance factors, which is largely theoretical and applies to any type of reciprocating pump.

Chapter III (about 100 pages) is entitled "Classification and Types." It undertakes to explain the numerous ingenious designs of single-cylinder steam ends that were devised to evade detail patents rather than because they possessed any marked inherent merits either practical or theoretical. The descriptions are too meager and the illustrations too incomplete to make the matter clear to a novice. For example, Fig. 28 (page 45) shows a piston in a position where it shuts off the steam port completely, and the means for getting steam into the cylinder to propel the piston is left to the imagination of the reader. The operation of the valve gear of duplex pumps is explained at length, and considerable space is devoted to a discussion of various designs of water cylinders.

The action of the cross-exhaust which makes the expansive use of steam possible in a direct-acting compound pump without compensating devices is described in a clear and interesting manner, and practical formulas are evolved for calculating the cylinder ratios of such pumps. There are also a number of elaborate tables of doubtful value, which purport to give the mean effective pressure referred to the high-pressure cylinder, and the steam force in pounds in multiple-expansion pumps of many sizes working under various boiler pressures, both condensing and noncondensing.

Two chapters are devoted to the mechanical design of water and steam ends, giving formulas—more or less empirical—for the strength and proportion of parts.

Chapter VI discusses sundry types of pumps from the standpoint of their suitability for different kinds of service. Chapter VII deals with the economic performance, or "duty" of pumps. It includes seven pages of tables, which claim to give the actual duty in millions of foot-pounds per 1000 lb. of steam over the whole range of sizes, from the tiny simple pump of 4-in. stroke working with 50-lb. boiler pressure to a triple-expansion condensing pump of 48-in. stroke working under a boiler pressure of 200 lb. Except in the case of a large water-works pump, carefully designed to meet conditions that can be predicted with accuracy, the duty of a direct-acting steam pump is pretty much of a joke, and this chapter should not be taken too seriously. Engineering literature is singularly free from reports of actual tests of ordinary direct-acting pumps, and the author does not undertake to supply this deficiency. The duties given in the tables are most probably calculated, and no evidence is offered to the effect that they are in close agreement with the results of actual experiment.

The book closes with a very brief chapter on the operation and adjustment of direct-acting pumps and with an appendix consisting of tables giving the frictional resistance of Pennsylvania and California oils in pipe lines of sundry lengths and diameters at various rates of flow.

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Essays on Promoting Efficiency

EXPERIENCES IN EFFICIENCY—By Benj. A. Franklin. [Works Management Library.] New York: The Engineering Magazine Co. Cloth; 5x8 in.; pp. xi + 167. $1.

HINTS CONCERNING THE ORGANIZATION OF WORKSHOPS AND FACTORIES—By Robert Grimshaw, Consulting Engineer; Lecturer, New York University School of Commerce, Accounts and Finance, Pratt Institute, etc.; author of "Catechisms of Locomotive and Stationary Steam Engines, Boilers and Pumps"; "Shop Kinks"; "Workshop Practice"; "Werkstatt Betrieb und Organization"; "System und Organization in kaufmaennischen Betrieben," and other practical works in English, French and German. New York: New York University Book Store, University Building, 32 Waverly Place. 4x6 in.; pp. 104. 50c.

Mr. Franklin's little book contains some articles, reprinted from *Engineering Magazine*, relating in conversational style a few cases of decreasing manufacturing costs and increasing workmen's rewards for labor. The author's particular contribution to the field seems to be a quality-piece-work scheme of payment for labor, by which the total wage secured depends both on quantity of output and reduction of waste. Some experience is cited with "gang piece-work" pay. Where a number of men were involved in a multitude of operations, the cost of the finished product was determined and used as the basis of a gang payment, which was divided among the various workmen in some proportion judged to be fair. The result was greater coöperation, increased and cheapened output, improved quality and larger wages per man.

Applying efficiency methods to the efficiency men themselves is an unusual theme taken up. The statistical clerks were induced to record the times of their own operations and this furnished the handle for scheduling progress of shop records. The men saw chances of improving their own work, and seven took on extra tasks that before would have required two more men.

There are also some interesting comments on building up a real cost-accounting system. Throughout the author displays a sensible moderation in scrapping old methods which may give good results—straight piece-work wages in some plants, for instance.

The Grimshaw pamphlet appears to be a condensation of lectures given at the New York University and the Pratt Institute. The text consists of tabular or skeleton arrangements of abbreviated expressions defining the aims and methods of organized business, the functions of manufacturing plants and productive departments. Handling stock and labor, reducing costs, increasing production, etc., are similarly taken up "in breathless style."

Descriptive Geometry for Draftsmen

REVIEWED BY ALTON L. SMITH*

THE ESSENTIALS OF DESCRIPTIVE GEOMETRY—By F. G. Higbee, M. E., Professor and Head of Department of Descriptive Geometry and Drawing, State University of Iowa. New York and London: John Wiley & Sons. Cloth; 6x9 in.; pp. vi. + 204. $1.80, net.

The author aims to present the subject from the viewpoint of the draftsman. The first fifth of the text explains the general principles of projection and discusses the elementary operations employed in the solution of space problems. The next fifth takes up 17 simple propositions relating to the point, line and plane, the statement in each case being followed by a discussion of the space solution and explanation of the geometric constructions used. The remainder of the book is devoted to the subject of surfaces. Each chapter is followed by a set of practice problems, the whole totaling nearly 300. One entire chapter deals with making paper models of sheet-metal work. The book concludes with an appendix giving useful geometric constructions.

To help the student visualize and vitalize his problem, the author makes use of solids instead of dealing with the geometric point, line and plane. Thus, finding the actual length of a line when its projections are given is presented as a problem of finding the overall length of the inclined brace of a wooden bracket. This method is supposed to overcome two difficulties. First, it is thought that a student can imagine a block of wood much easier than he can conceive of a wire or sheet of cardboard. Second, it is believed that the student can more quickly apply his principles to engineering problems if he has worked out his elementary problems in magnitudes of commercial shape and dimensions instead of the usual ones employed by the mathematician. The problems presented cover a fair range and in most cases have a "practical flavor" rather than real commercial application.

The large amount of space given to sheet-metal pattern work and the total exclusion of some other useful topics will impair the value of the book for those who desire the treatment to be comprehensive, even though brief. However, the matter on surfaces probably constitutes the most valuable feature of the book.

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Fundamentals of Hydraulics

ELEMENTS OF HYDRAULICS—By S. E. Slocum, Professor of Applied Mathematics in the University of Cincinnati. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xi + 294; 210 illustrations. $2.50, net.

Professor Slocum evidently has aimed to instruct the student in the fundamentals of hydraulics and simultaneously to impress him on certain important practical applications of theory which should be well known. The book is another evidence of the tendency to break away from academic presentations of pure theory to secure the interest of the student and to visualize the abstractions which once were all too exclusively dealt with.

The book starts off with a brief review of the old academic "hydrostatics"—properties of water, pressure phenomena, properties of floating bodies, etc.—but into this is injected a consideration of presses, accumulators, jacks, elevators, dams, locks, barges, etc. This is done partly by inserted discussions and partly by a group of real and hypothetical engineering problems. The Kensico dam and Keokuk lock are among the actual structures considered.

The convenient term "hydrokinetics" appears here, as in the more academic treatises; but the treatment follows the lines indicated for the preceding section. "Hydrodynamics" is a term also retained to make the subject of hydraulic machinery sound formidable. The division of the book among these parts is 17, 40, and 43 per cent.

In taking up hydrokinetics the formula for flow out of orifices, over weirs and through pipes and nozzles is developed. The author introduces early the idea of stream lines and liquid veins to facilitate the later discussions of kinetic pressure and stream gaging. Venturi meters and siphon spillways are also treated.

Flow in open channels follows, the Kutter, Bazin and Chezy formulas being briefly presented as experimental deductions. Stream gaging by current meters is mentioned, and the use of pitot tubes is discussed at some length. Six pages are devoted to backwater curves in channels—not too much space considering the immediate importance of backwater from stream obstructions. Waterworks problems figure in the appendix to hydrokinetics.

Hydrodynamics is attacked by studying impact on various stationary and moving surfaces, as an introduction to impulse wheels. The reaction of jets serves to open up the subject of reaction turbines. Both classes of machines are presented in their practical details as well as in their underlying theories.

One of the most interesting and useful parts of the book is the review of design characteristics as developed in this country by Zowski and Baashuus (*Engineering News* of Jan. 28, 1909, and Mar. 2, 1911). Of course this is not gone into far enough so that designing can proceed with this text as a guide, but enough is given to be of great aid in understanding the proper selection of wheels. The scope of the section on centrifugal pumps may be similarly described.

Not all the minor matters have been here noted—such as water hammer and displacement pumps; their treatment is in keeping with their importance compared with the other sections noted herein.